LAUDA

Operating Instructions

TD 3

Automatic Tensiometer

LMT 850

Valid from series: 1

YAME0022 Version 06/08/09

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First some safety information

Before you operate the device, read all the instructions and safety information thoroughly. If you have any questions or concerns, please feel free to call us.

Follow the instructions regarding installation, operation, etc., as only then can improper handling of the device be eliminated and the full warranty coverage maintained.

- The device is supplied with voltage from a bench power supply unit. All voltage can be removed from the device using the switch on the bench power supply unit. The device is switched off using this on/off switch.
- Switch off the device and withdraw the mains plug during:
- – service and repair work,
- – when moving the device.
- Transport the device with care.
- The device and its internal parts, in particular the highly sensitive load cell, can be damaged:
- – by dropping,
- – by vibration.
- The device may only be operated by appropriately instructed personnel.
- Do not put the device into operation when:
- – it is damaged,
- – cables (no only the mains cable) are damaged.
- Only use the device for its intended purpose.
- Do not make technical modifications to the device.
- Have service and repair work carried out only by specialists.

The operating instructions contain additional safety information which is identified with a triangle with an exclamation mark ⚠. Read and follow the instructions. Ignoring the instructions can lead to severe consequences, e.g. damage to the device or other property, or to personal injury.

Technical modifications reserved.

Table of contents

1 Safety information

General safety information

Surface and interfacial tension are determined with a tensiometer. It may be necessary to stabilise the temperature of samples to be tested. Hazards arise from this due to high or low temperatures, fire and the general hazards due to the application of electrical energy. The user is extensively protected by the application of the relevant standards. Further hazard sources can arise from the type of material for which the temperature is to be stabilised or from the sample to be measured, e.g. on exceeding or undercutting certain temperature thresholds or with the fracture of the container and reaction with the tempering liquid.

It is not feasible to include all possible situations. They remain essentially subject to the judgement and responsibility of the operator.

The devices may only be used as intended, that is as described in this operating manual. This includes operation by instructed specialist personnel.

The device fulfils the following EU directives:

- Low Voltage Directive 73/23/EEC
- EMC Directive 89/336/EEC

Applied harmonised standards:

- DIN EN 61326-1 (IEC 61326-1)
- DIN EN 61010-1 (IEC 61010-1)
- DIN EN ISO 9001:2000

The devices are **not** designed for use under medical conditions according to DIN EN 60601-1 or IEC 601-1.

Other safety information

- Only connect the devices to grounded mains sockets.
- Withdraw the mains plug before cleaning, servicing, or moving the tensiometer.
- Have repairs carried out only by specialists.
- Measurements and display accuracy apply under normal conditions according to DIN 12876. High frequency electromagnetic fields may lead to less favourable values in special cases. Safety is not impaired.

Special symbols:

	Be careful!	This sign is used when improper handling can lead to personal injury.
	Note:	Here, something in particular needs the reader's attention. In certain circumstances this includes a note about a hazard.
⇨	Reference	Refers to further information in other chapters.

2 Brief instructions

These brief instructions are intended to give you a quick introduction to the operation of the device. However, for the safe operation of the tensiometer it is essential to read the instructions completely and carefully and to follow the safety information.

2.1 Brief description and application

The LAUDA Tensiometer TD 3 is used for the measurement of surface and interfacial tension, for the determination of the density of liquids and for the measurement of smaller weights. The device consists of a measurement console and the COMMAND console. It has an integral, precise electromagnetic load cell and operates fully automatically as a stand-alone device without an accompanying PC. All results can be saved in an internal memory in the TD 3, output to an optionally obtainable printer and transferred via the RS232 interface to a commercially available PC.

The TD 3 is particularly suitable for:

- Universities, advanced technical colleges, teaching facilities and other training establishments.
- Operational and quality laboratories.
- Research and development departments.

The possible applications are plentiful, including:

- The determination and test of physical properties of the types listed above on organic and inorganic liquids, solutions and dispersions.
- Development and examination of surface-active substances (tensides, emulsifiers, etc.) and for the detection of such substances in waste water and water courses.
- Tenside content determination below the CMC.

It is possible to carry out a wide variety of measurement tasks by using the most varied test probes in conjunction with precise weighing technology and high quality electronics.

In the case of surface and interfacial tension the following test probes specified according to ASTM D971 and DIN 53914 are used:

- The Wilhelmy platinum plate.
- The du Noüy platinum/iridium ring.

For density measurements:

- A glass displacement body.

When using the Lauda PTT Peltier Thermostating Unit with integral stirrer, measurements over a temperature range of 5-70°C can be carried out.

2.2 Operating principle

Determination of surface and interfacial tension of liquids

The measurement of surface and interfacial tension is carried out using the Wilhelmy plate or du Noüy ring method. The vertical force is measured which is exerted on the test probe by the surface or interface of the liquid.

An especially sensitive, displacement-free measurement system is required to acquire this force. A force measurement system of this type is the main constituent component of the TD 3 measurement console. This is achieved through electromagnetic compensation in the force transferred via the test probe onto a measuring beam. An optoelectronic detector supplies the position determination of the measuring beam needed for displacement-free measurement.

In the case of measurement with the du Noüy ring, the TD 3 facilitates the up and down movement of the sample table, which is required for acquiring the maximum force, through a limited force range defined by the user.

When using the Wilhelmy plate, the table movement stops immediately once the measurement system has registered contact between the plate and the liquid.

After entering the measuring parameters, such as measurement method, number of tests, stability criteria (standard deviation), the measurement can be started by the press of a button. To raise or lower the test liquid without vibration the TD 3 has a motor-controlled sample table which enables the necessary vibration-free table movement at a speed specified by the user.

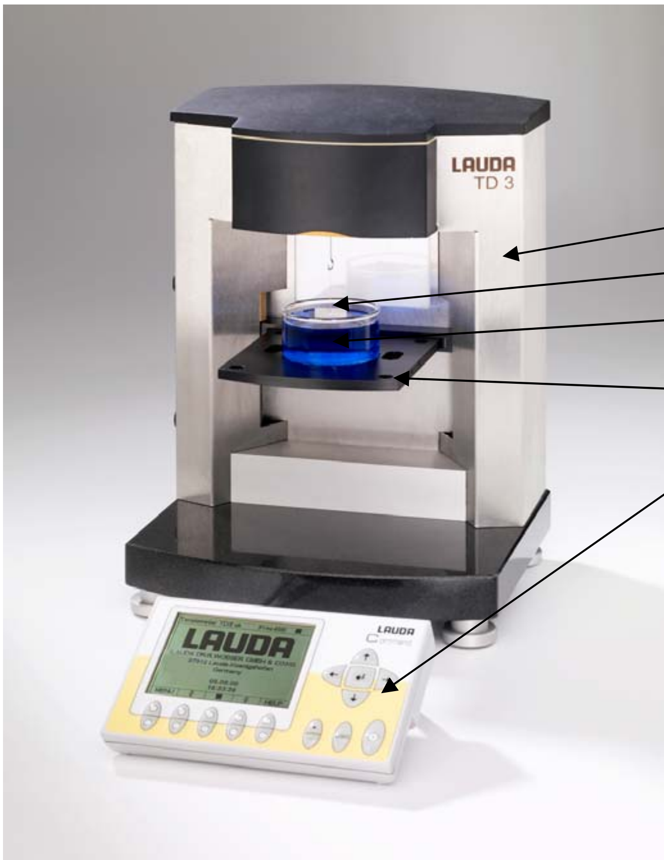
Density measurement

The determination of the density occurs by dipping a suitable sample probe, previously tared in air, into the liquid to be measured. The measured upthrust corresponds to the weight of the displaced liquid. If the volume of the buoyancy probe is known, the density can be directly determined.

Weight measurement

The sample to be measured can be attached, either directly or indirectly using a suitable holder, to the hook on the measurement system and its weight determined.

3 Controls and functional elements



1 Measurement console

2 Test probe

3 Sample

4 Sample table

5 Mobile COMMAND Console

6 Optional temperature sensor connection

7 Optional stirrer connection

8 RS232 port (protocol printer)

9 Height stop

10 Adjustable upper lifting limit for the sample table

11 External power supply connection

12 CAN port for COMMAND console

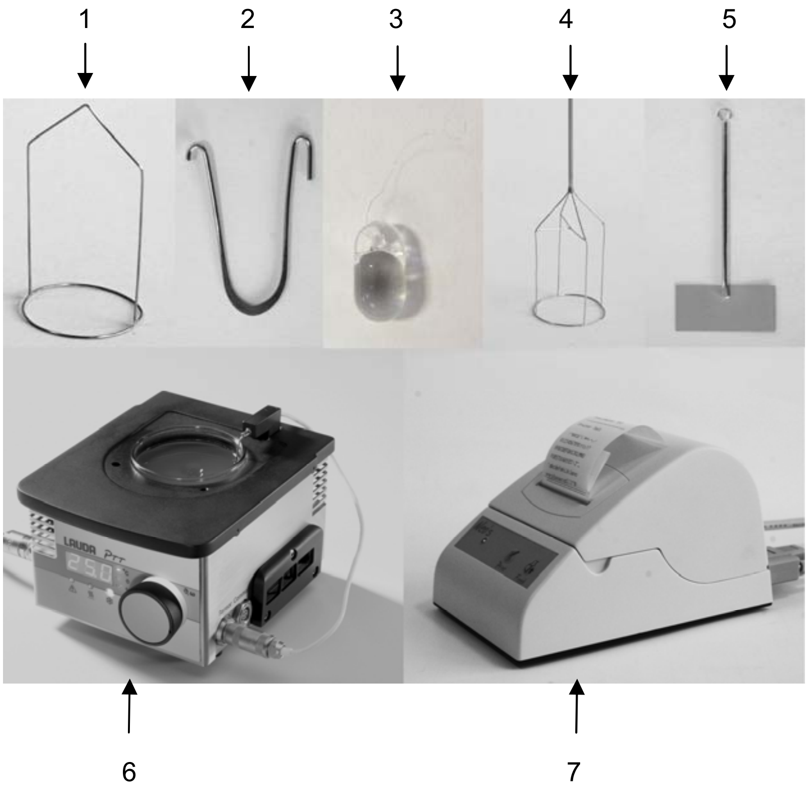
13 Adjustable upper lifting limit for the sample table

☞	For PTT operation the height stop must be latched to prevent damage to the PTT Peltier Thermostating Unit or to the TD 3 Tensiometer when the sample table is raised.

Height stop for standard operation

Height stop for PTT operation

3.1 Accessories



Standard accessories:

1 Du Noüy measuring ring (2-limb, Pt/Ir)

2 Calibrating weight 500 mg

3 A glass displacement body.

Optional accessories:

4 Du Noüy measuring ring (4-limb, Pt/Ir)

5 Wilhelmy plate (Pt/Ir)

6 PTT Peltier Thermostating Unit incl. plastic cover, temperature sensor and PTFE stirring rod.

7 Protocol printer

4 Device description

4.1 Ambient conditions

The use of the tensiometer is only admissible under the conditions specified in DIN EN 61010-2-010:2003 and DIN EN 61010-1:2001:

- Initial and routine operation of the device only indoors.
- Impermeable, flat, non-slip, non-flammable standing area.
- Normal ambient conditions.
- Contamination Level 2

4.2 Measurement methods

Density measurement Measurement of the density of liquids by means of the method according to Archimedes, i.e. using a glass buoyancy probe.

Plate measurement Measurement of the surface and interfacial tensions by the Wilhelmy method using a Pt/Ir plate specified according to DIN 53914, ASTM D971 and other standards.

Ring measurement Measurement of the surface and interfacial tensions by the du Noüy method using a Pt/Ir ring specified according to DIN 53914, ASTM D971 and other standards.

Weight measurement Measurement of small weights (max. 5 g).

4.3 Installation of the TD 3

1. Unpack the device and put it together. Choose a stable, horizontal operating position which is not affected by building vibrations. Connect the COMMAND operating unit to one of the two CAN sockets at the back of the device.
2. Check whether the switch on the power supply unit is set to the position "Off = 0".
3. Connect the device to the external power supply unit (connection socket at the rear of the device) and connect the power supply unit to a mains socket having an earth conductor.
4. Switch on the TD 3 using the switch on the external power supply unit. The background lighting of the table switches on and after a few seconds a window with the main menu (⇨ 4.4.3) appears on the display.
5. Remove the transport protection. To do this, lower the table using the soft key ⇳ and remove the protective tube.
6. If other accessories (⇨ 3.1) are supplied, assemble them appropriately and connect them. For safety reasons the device must always be switched off when connecting other components.
   - Connect the optional protocol printer to the 9-pole socket (RS 232) of the TD 3.

☞	This connection is only used for data transfer to the printer. A PC must not be connected to this point.

   - For the data transfer to the PC a COM port (preferably COM1) on the PC is connected to the RS 232 socket on the COMMAND operating unit.

☞	The data transfer software and the data transfer cable for the PC are not included in the accessories as standard and must be ordered separately (⇨ 8.5.1).

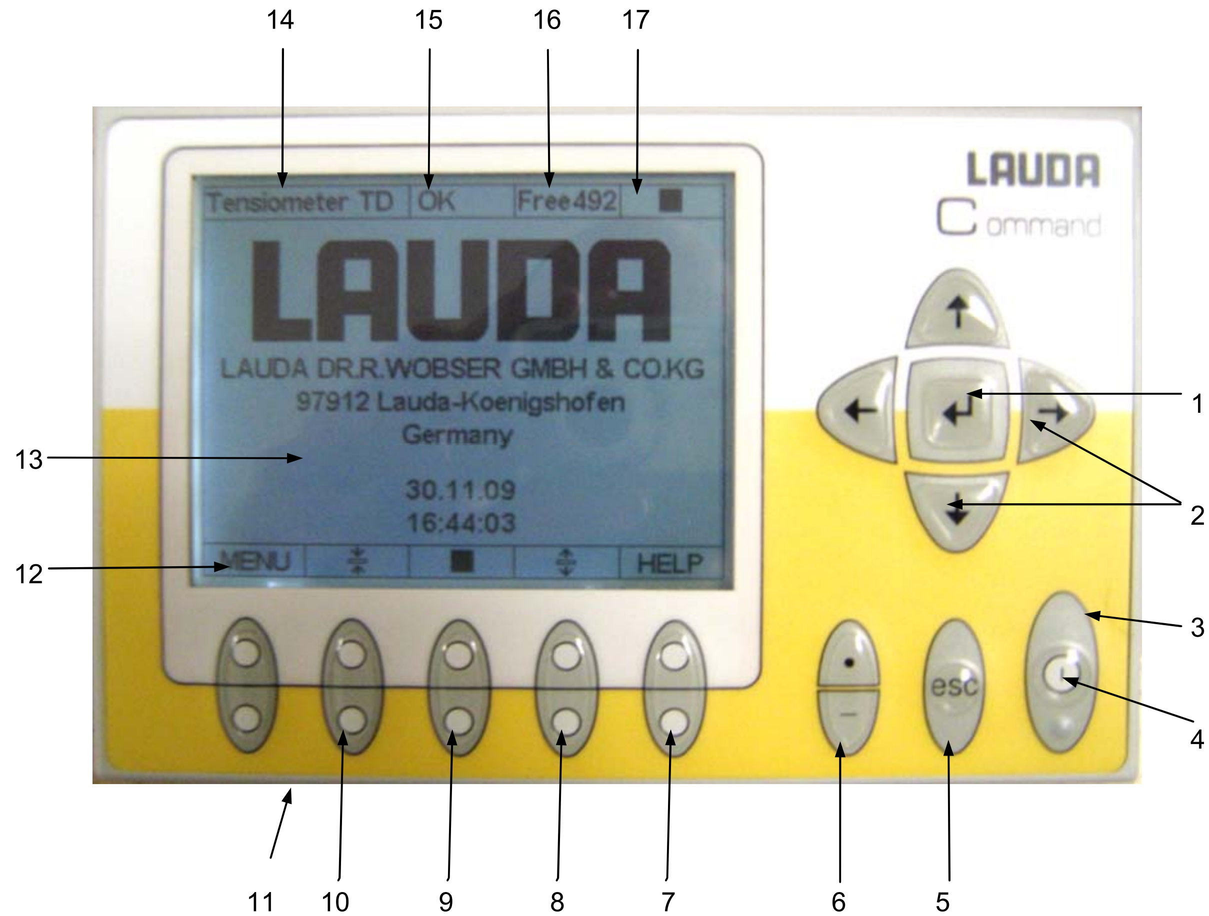
   - Place the optional PTT Peltier Thermostating Unit in position and connect it.

☞	Follow the operating instructions for the PTT Thermostating and Stirring Unit. With the PTT Peltier Thermostating Unit set up the use of the table displacement is restricted.

7. Suspend the plate, ring or buoyancy probe as the preparation requires. To prevent damage or contamination the test probe must always be suspended using the tweezers after proper cleaning.
8. Fill the sample container with sample liquid and place it into the corresponding recess in the sample table or in the thermostatic bath.
9. After checking all connections switch on the device again. The main menu appears on the display of the COMMAND operating unit.
10. From here the various measuring modes can be started and the settings made which are needed for them.
11. To switch off set the switch on the power supply unit to the "Off" position.

4.4 COMMAND operating unit

The COMMAND is the central operating unit of the TD 3.

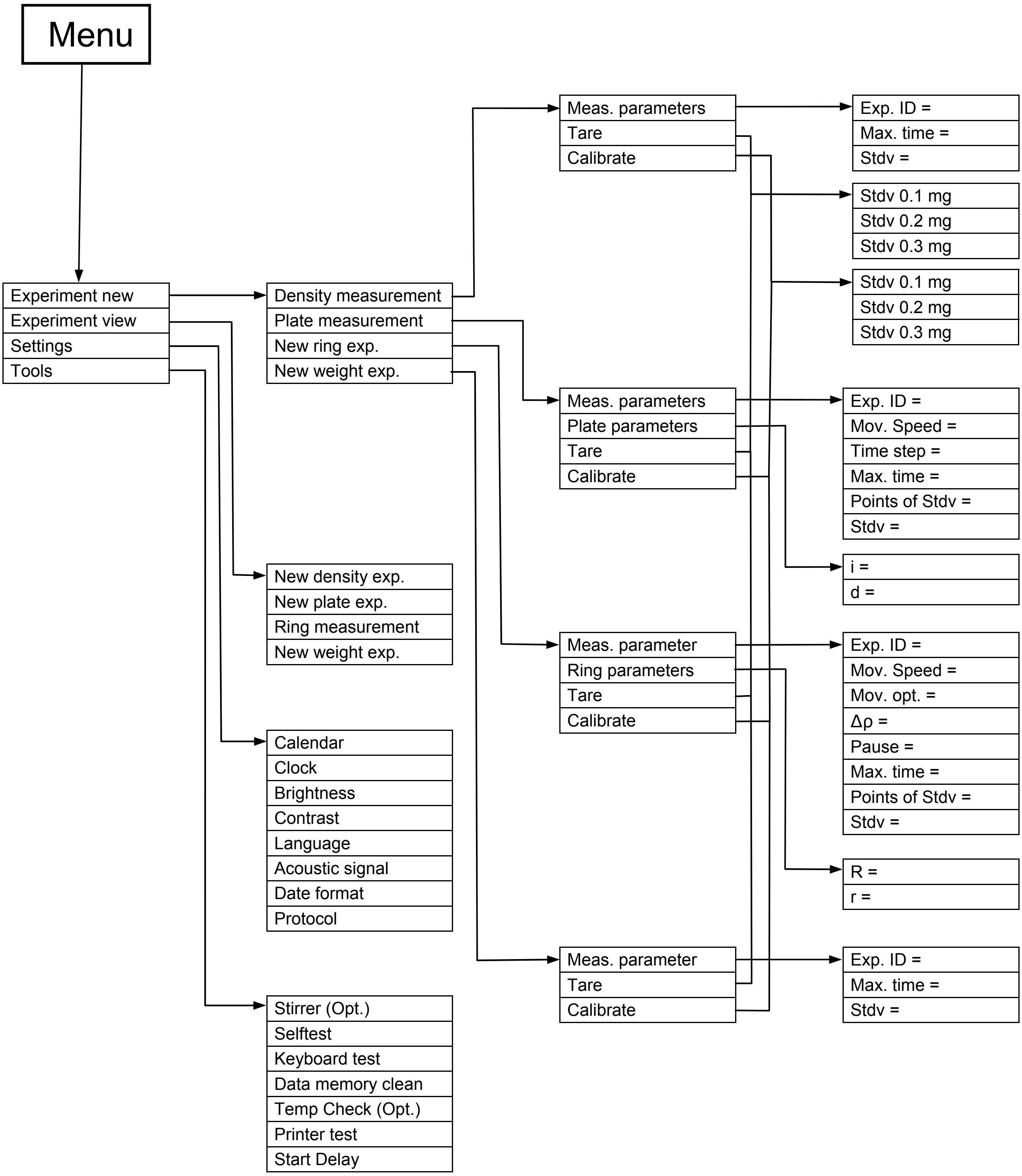


1.	Enter key	12.	Soft-key functions
2.	Navigation keys	13.	Graphic display status line
3.	Measurement start/stop	14.	Current action
4.	Yellow LED	15.	Device status
5.	Escape key	16.	Free memory
6.	Decimal point or "-" character	17.	Table movement status

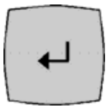
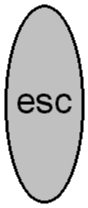
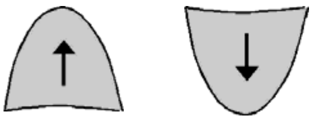
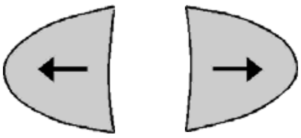
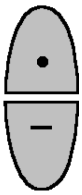
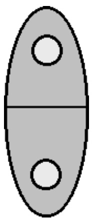
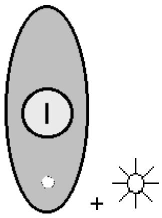
Soft-key duo keys

7. Help (not currently assigned)
8. Table movement downwards
9. Stops table movement
10. Table movement upwards
11. RS 232 / RS 485 socket (located at the rear of the COMMAND).

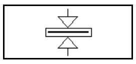
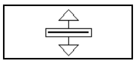
4.4.1 Menustructure: COMMAND



4.4.2 COMMAND keyboard

	**Enter key / Return:** Confirms the selection, entries or changes. Operation remains within the current menu.
 	**"Escape" key** 1. Return to the previous screen without implementing the changes in the menus "Measuring parameters", "Settings" and "Tools" 2. Interrupts the taring and calibration process without changing the previous taring and calibration constants.
	**Up / down navigation keys** 1. Selection of menu entries upwards or downwards. 2. For increasing or decreasing the selected figure in the numerical entry window.
	**Navigation keys (left / right)** 1. Skipping between various (sub-)menu windows: Right: First entry in the submenu is selected Left: Last entry of the main menu is selected 2. Used for selecting the figure in the numerical entry window.
	**Duo key:** Top: Decimal point key Bottom: Minus symbol (not currently used)
	**Soft keys:** 1. Keys with the assignment shown above the respective key for both keys the same. 2. Keys with the figure assignment shown above in the display: Top key: Figures in the top line Bottom key: Figures in the bottom line
	**Measurement:** The selected measurement has to be started from the measuring parameter entry window by pressing a key. When the LED is illuminated, a measurement is running. It is terminated immediately by pressing this key and the illumination is turned off. The evaluation is carried out using the last measurements taken.

Soft keys after start and "Main menu" window

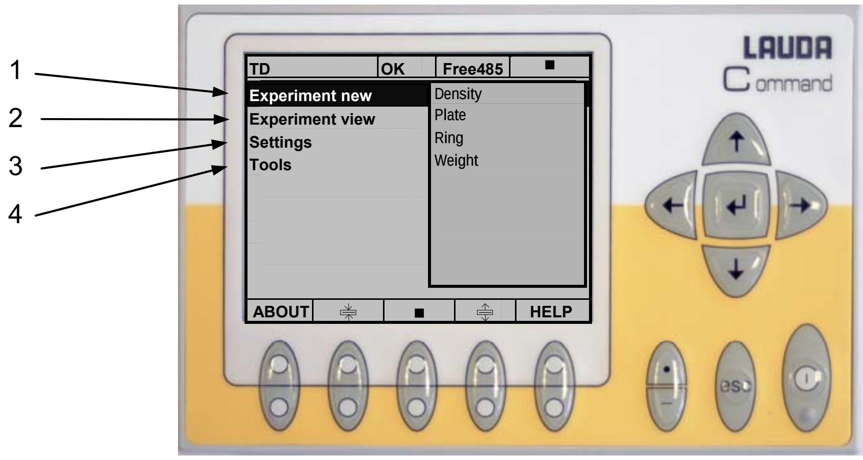
MENU	Selects the main menu.
	Starts the table movement upwards, i.e. the test probe moves downwards relative to the sample table. When the upper limit switch, which can be adjusted by the user, is reached, the table movement stops. The direction of movement is indicated by the same symbol in the information line.
■	The movement is stopped. The "idling state" is indicated by the same symbol in the information line.
	Starts the table movement downwards, i.e. the test probe is raised relative to the sample table. When the lower limit switch, which can be adjusted by the user, is reached, the table movement stops. The direction of movement is indicated by the same symbol in the information line.
HELP	Not currently available.

Soft keys in the results window

MENU	Selects the main menu.
SAVE	Saves the final result together with the sample ID code and all measuring parameters in the internal memory of the COMMAND. Here, up to 500 data records can be saved. The number of memory locations still available is displayed in the information line.
PRINT	The final result is output together with the sample ID code and all measuring parameters to the (optional) protocol printer.
NEW	Start of the next measurement with the selected method. To do this the corresponding menu opens for changing the parameters and settings.

4.4.3 Main menu of the TD 3

Access to the main menu "TD 3" is obtained via the soft key MENU. The submenus can be found with the navigation keys. They are selected by confirmation with ↵ Return.



1. **Experiment new**

   Selection of the method for the next measurement.

2. **Experiment view**

   Displays the measurements (max. 500) saved in the internal memory.

3. **Settings**

   Basic settings such as date, language etc..

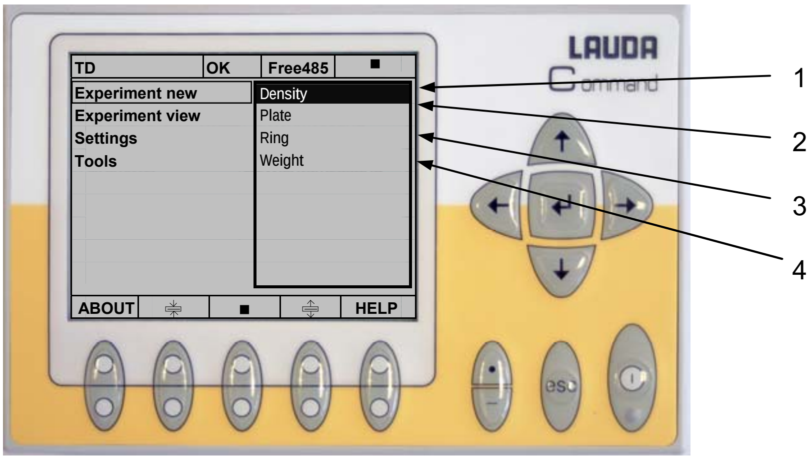
4. **Tools**

   Activates additional functions, e.g. clearing the memory, operation of the (optional) magnetic stirrer, reading the (optional) thermometer, system test.

4.4.4 Submenu "Experiment new"

The various measurement methods available can be chosen.

They are selected by confirmation with Return.

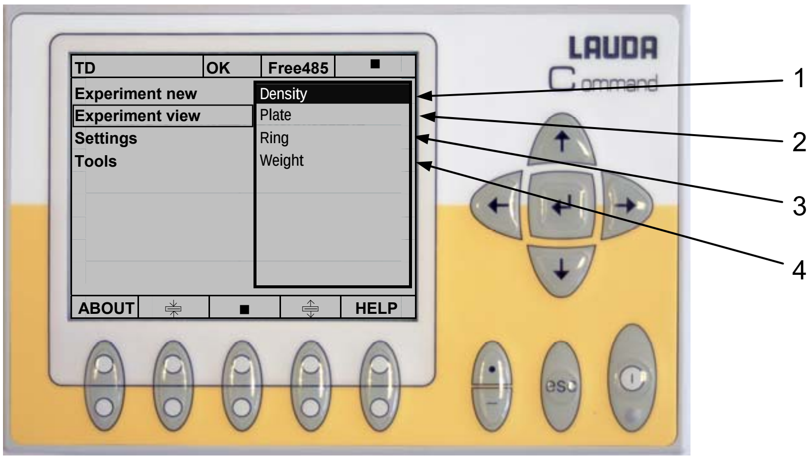


1. **Density measurement** (⇨ 6.1)
2. **Plate measurement** (⇨ 5.1)
3. **Ring measurement** (⇨ 5.1)
4. **Weight measurement** (⇨ 6.2)

4.4.5 Submenu "Experiment view"

The measurement methods available can be chosen.

They are selected by confirmation with Return.

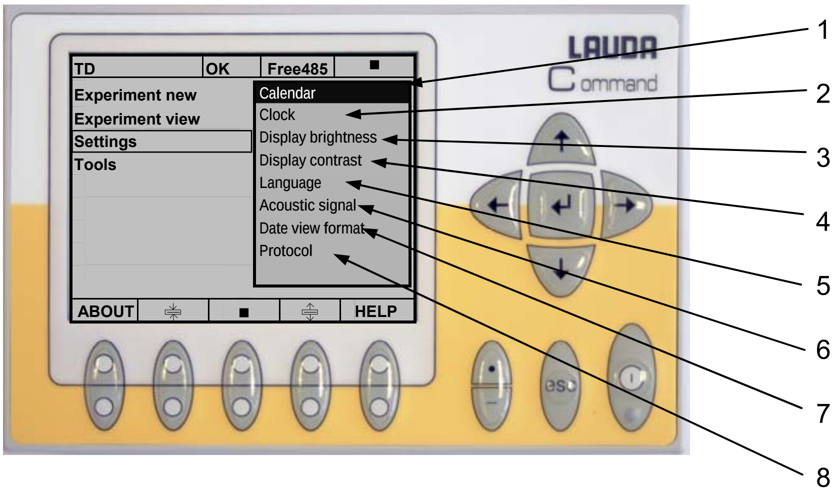


1. **Density measurement** (⇨ 6.1)
2. **Plate measurement** (⇨ 5.1)
3. **Ring measurement** (⇨ 5.2)
4. **Weight measurement** (⇨ 6.2)

4.4.6 Submenu "Settings"

The various settings available can be chosen.

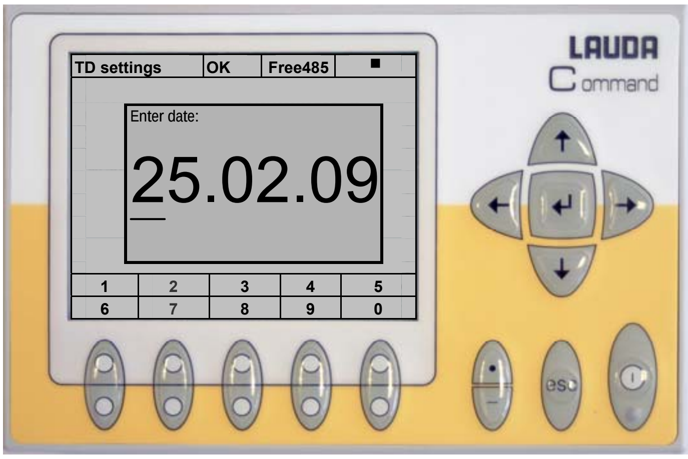
They are selected by confirmation with ↵ Return.



1. **Calendar**
   Sets or changes the date.
2. **Clock**
   Sets or changes the time.
3. **Brightness**
   Can be changed over 8 levels.
4. **Contrast**
   Can be changed over 8 levels.
5. **Language**
   Provides choice of English or German menu language.
6. **Acoustic signal**
   Volume can be controlled over 4 levels.
7. **Date view format**
   DD.MM.YY or MM.DD.YY is possible.
8. **Protocol**
   Activates additional functions, e.g. clearing the memory, operation of the (optional) magnetic stirrer, reading the (optional) thermometer, system test.

4.4.6.1 Calendar

Sets or changes the current date.



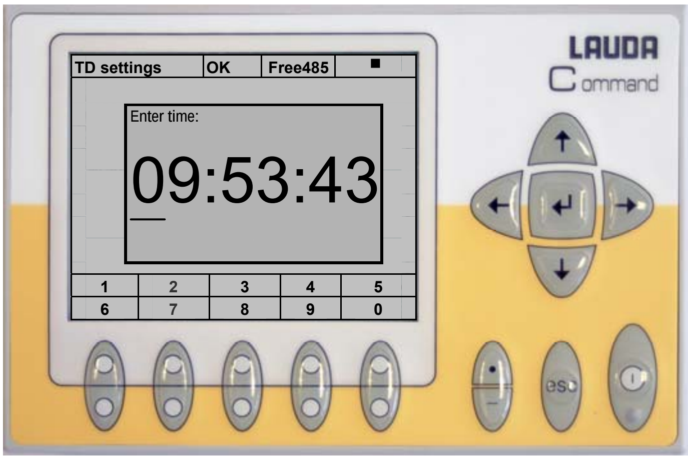
The flashing underscore marks the figure to be changed.

The individual figures can be selected with the cursor keys and changed using the corresponding soft key.

Confirmation with .

4.4.6.2 Clock

Sets or changes the current time.



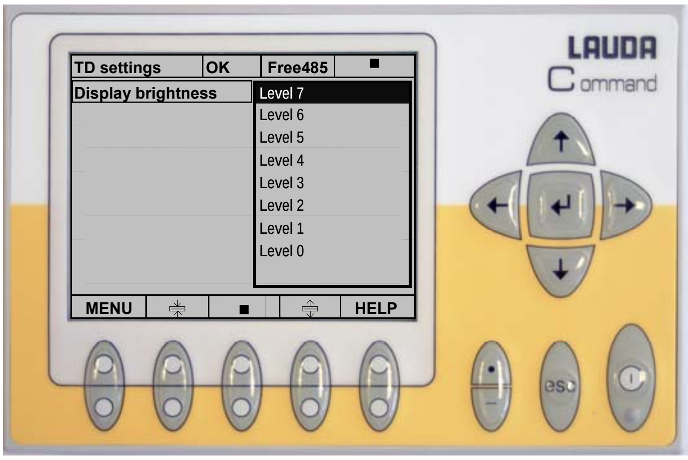
The flashing underscore marks the figure to be changed.

The individual figures can be selected with the cursor keys and changed using the corresponding soft key.

Confirmation with .

4.4.6.3 Brightness

Sets or adjusts the display brightness.



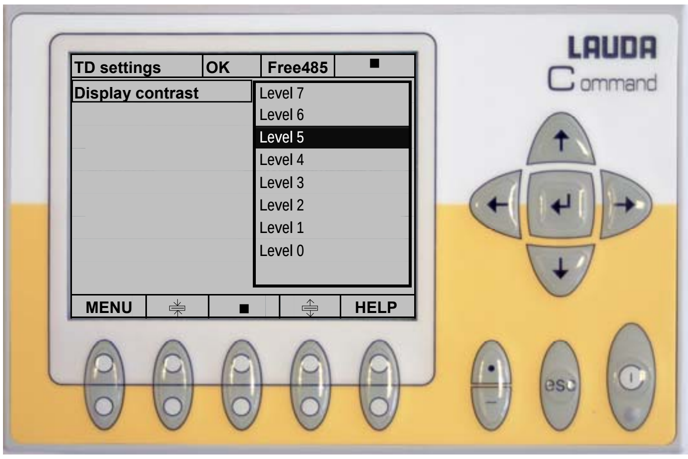
The level with the dark background marks the current setting.

The individual levels can be selected with the cursor keys .

Confirmation with .

4.4.6.4 Display contrast

Sets or adjusts the display contrast.



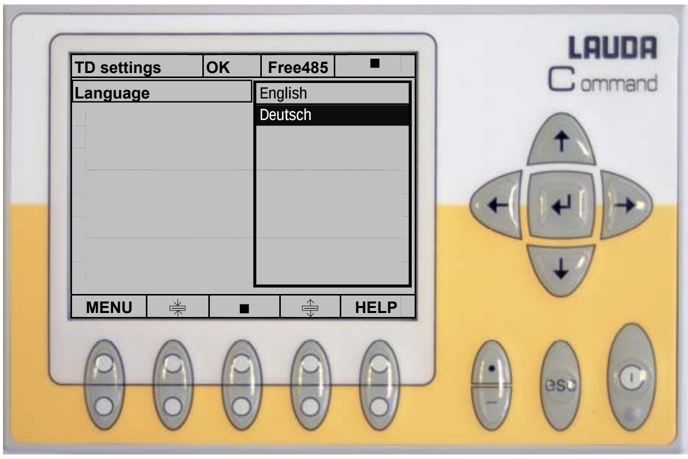
The level with the dark background marks the current setting.

The individual levels can be selected with the cursor keys .

Confirmation with .

4.4.6.5 Language

Selects the language for the menu guidance and printout.



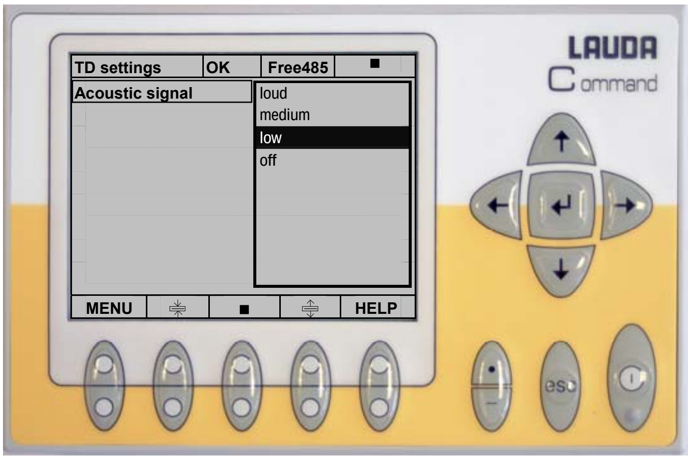
The strip with the dark background marks the current setting.

The individual levels can be selected with the cursor keys ↑ ↓.

Confirmation with ↵.

4.4.6.6 Acoustic signal

Sets and adjusts the volume of the acoustic signal and switches it off.



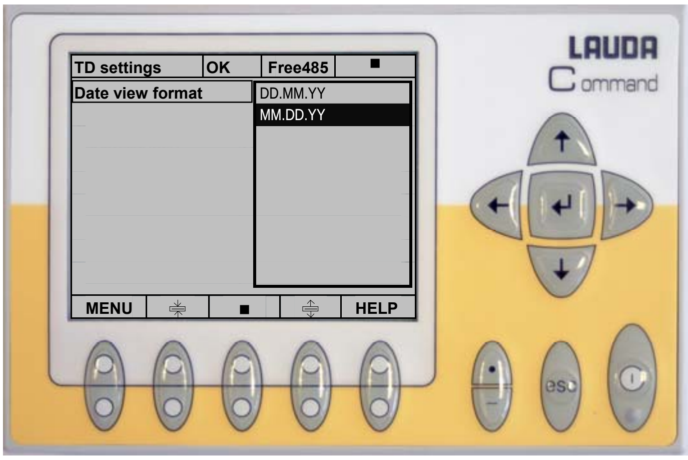
The strip with the dark background marks the current setting.

The individual levels can be selected with the cursor keys ↑ ↓.

Confirmation with ↵.

4.4.6.7 Date view format

Sets the date output format for the display and printout.



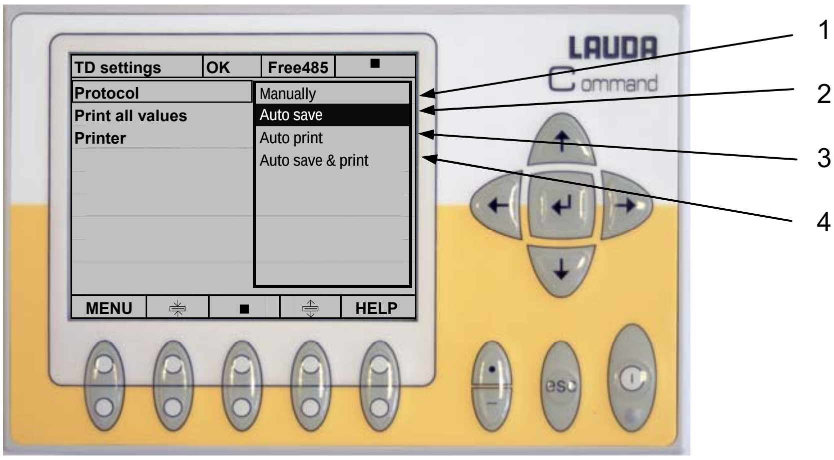
The strip with the dark background marks the current setting.

The appropriate output can be selected with the cursor keys ↑ ↓.

Confirmation with ↵.

4.4.6.8 Protocol

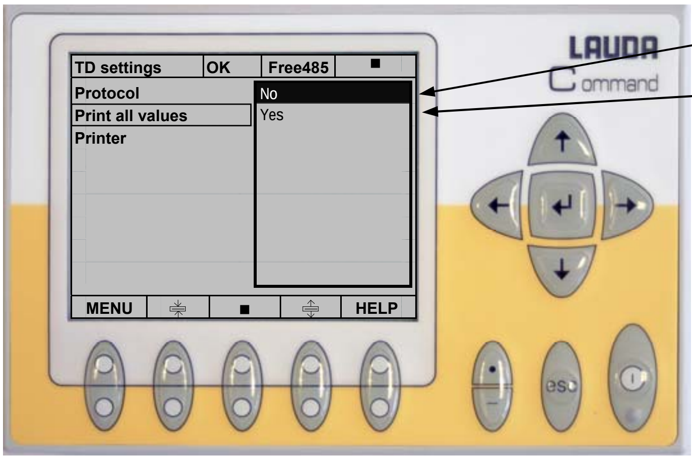
Specifies the documentation



1. **Manually**
   Saves and prints using the appropriate soft key at the end of the measurement or in the submenu Experiment view.
2. **Auto save**
   Automatically saves the measurement results and setting parameters at the end of a measurement.
3. **Auto print**
   Automatic prints the measurement results and the setting parameters at the end of a measurement.
4. **Auto save & print**
   Automatic saves and prints the measurement results and the setting parameters at the end of a measurement.

4.4.6.9 Print all values

With the setting "Print all values" printing occurs directly during the measurement. All individual measurements are output to the printer.



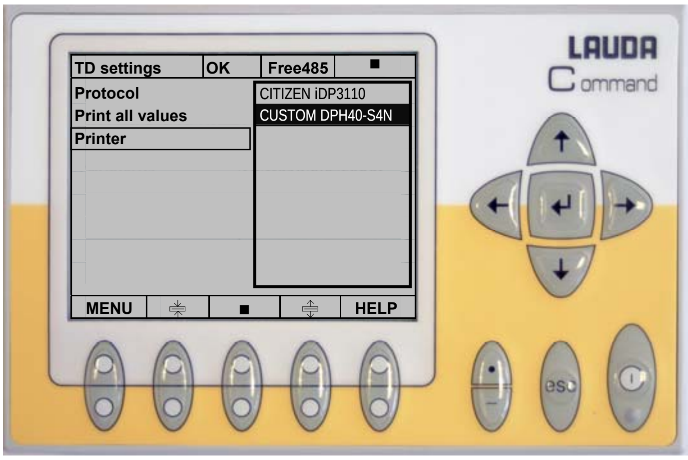
The strip with the dark background marks the current setting.

The appropriate output can be selected with the cursor keys .

Confirmation with .

4.4.6.10 Printer

Sets up the connected printer.



The strip with the dark background marks the current setting.

The appropriate output can be selected with the cursor keys .

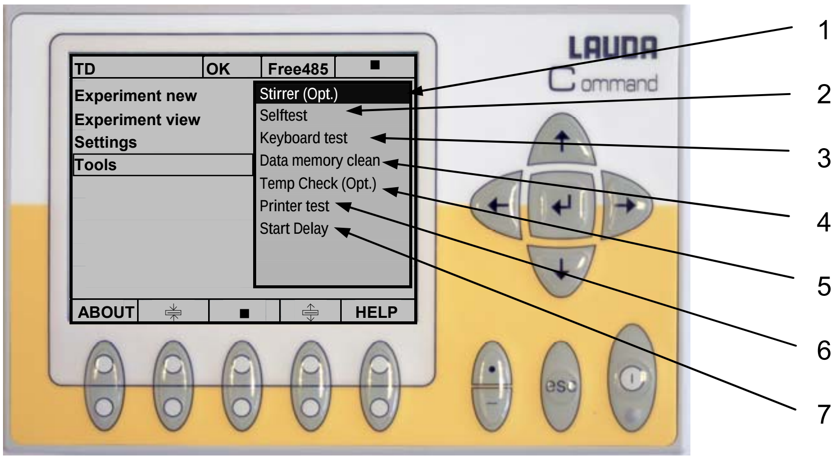
Confirmation with .

☞	The printer currently available as an accessory is the CUSTOM DPH40-S4N. (⇨ 8.5.1)

4.4.7 Submenu "Tools"

Additional settings for accessories and testing individual components. The appropriate submenus can be displayed.

They are selected by confirmation with ↵ Return.



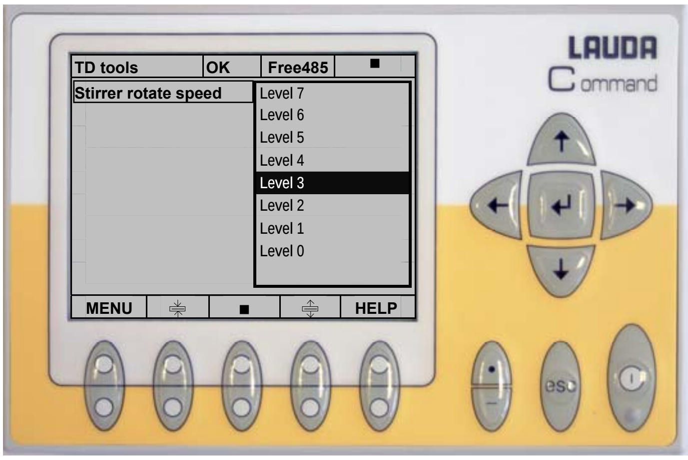
1. **Stirrer (Opt.)**
   For mixing dispersed samples. The stirring frequency can be varied over 8 levels.

☞	This stirrer setting currently has no function with the PTT Peltier Thermostating Unit which is available as an accessory. The stirring frequency is set directly on the PTT. Follow the PTT operating instructions.

2. **Selftest**
   The results of the selftest automatically executed each time the device is switched on (status of CPU and RAM as well as system information) are displayed here.
3. **Keyboard test**
   This enables a functional test of all keys on the COMMAND module.
4. **Data memory clean**
   All saved measurement results are erased. The memory is released.
5. **Temp Check (Opt.)**
   This test displays the current temperature measured by the external temperature sensor.
6. **Printer test**
   Prints a test page.
7. **Start Delay**
   Enables to delay start exact to the second.

4.4.7.1 Stirrer (Opt.)

Sets the stirring frequency for an external stirrer.



The level with the dark background marks the current setting.

The individual levels can be selected with the cursor keys ↑ ↓.

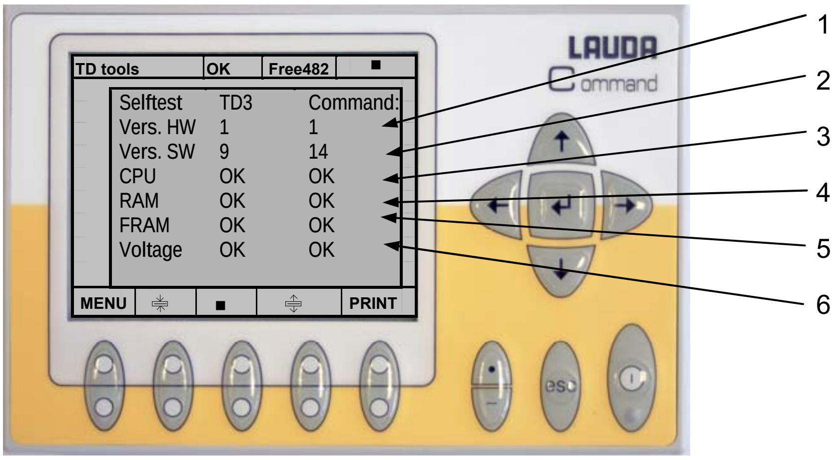
Confirmation with ↵.

☞	Currently, an external stirrer cannot be controlled. We recommend the use of the PTT Peltier Thermostating Unit.

4.4.7.2 Selftest

Displays the results of the selftest which is executed automatically each time the device is switched on.

The results are listed separately for the TD 3 and COMMAND.

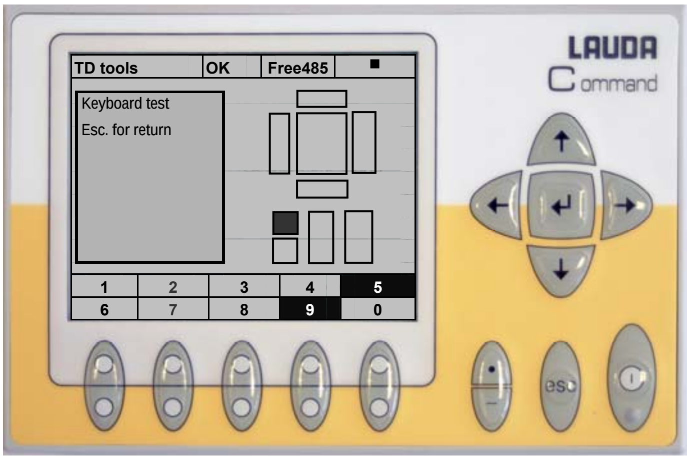


1. **Vers. HW**
   Hardware version
2. **Vers. SW**
   Software version
3. **CPU**
   Main processor (CPU)
4. **RAM**
   Main memory
5. **FRAM**
   Non-volatile memory
6. **Voltage**

4.4.7.3 Keyboard test

Functional test of the individual keys on the COMMAND.

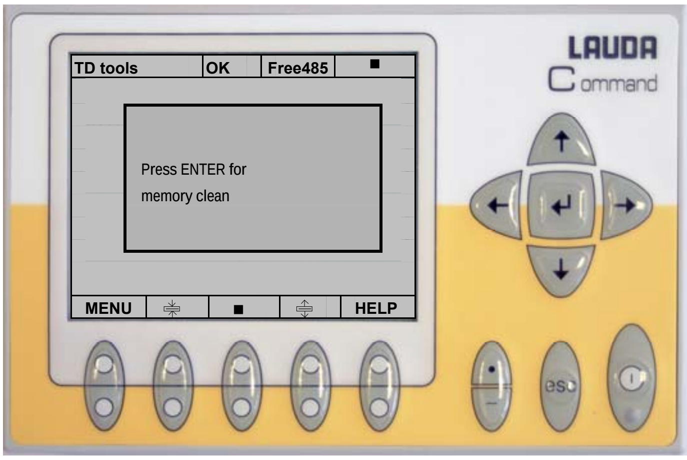
The keys are shown simplified. The pressed key appears dark and remains dark when functioning correctly.



Quit with .

4.4.7.4 Data memory clean

Clears all data from the internal memory.



Confirm with .

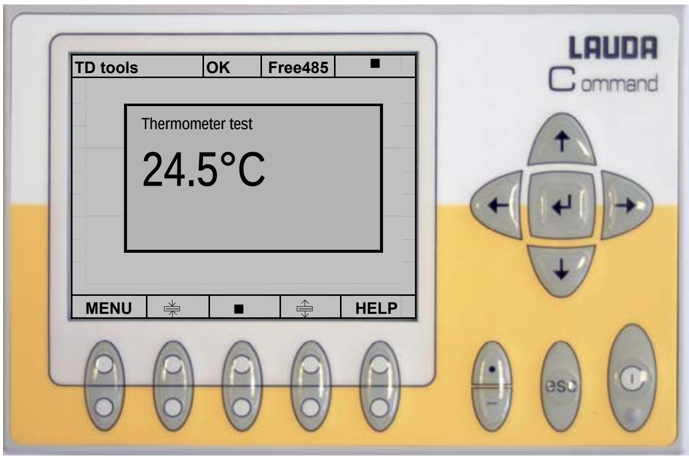
Cancel with .

Return to main menu with the soft key **MENU**.

☞	**Free500** appears in the status line after clearing and memory space for 500 measure-ments is available.
☞	The set parameters are retained.

4.4.7.5 Temp Check (Opt.)

Tests the external thermometer. The measured temperature is displayed.



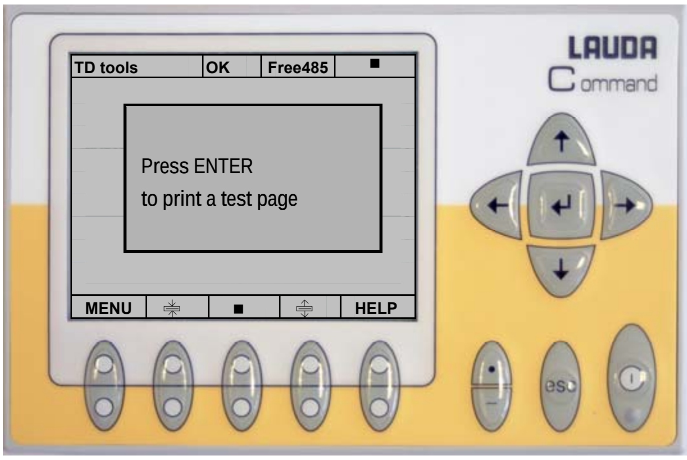
Cancel with .

Return to main menu with the soft key **MENU**.

☞	If no thermometer is connected, the field remains blank.

4.4.7.6 Printer test

Prints out a test page to an external printer.



Confirm with .

Cancel with .

Return to main menu with the soft key **MENU**.

```
==================
LAUDA
Tensiometer TD3
--------------------------------

Printer test

 !“#$%&`()*+,-./
0123456789:;<=<?
@ABCDEFGHIJKLMNO
PQRSTUVWYZ[\]~_
`abcdefghijklmno
pqrstuvwxyz{¦}~§
 !“#$%&`()*+,-./
0123456789:;<=<?
@ABCDEFGHIJKLMNO
PQRSTUVWYZ[\]~_
`abcdefghijklmno
pqrstuvwxyz{¦}~§

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Printed 25.02.09  16:05:38
==================
```

5 Measurement of surface and interfacial tension

5.1 Measurement with the Wilhelmy plate (optional accessory)

5.1.1 Measurement preparation

1. Switch on the TD 3 by the on/off switch on the external power supply unit.
2. Using the soft key or move the sample table into a central position or, if using the PTT Peltier Thermostating Unit, the lowest position. Make sure there is sufficient space for changing the sample beaker and for suspending the Wilhelmy plate.
3. Freely suspend the Wilhelmy plate on the hook of the measurement system.

☞	Use tweezers - it is essential to avoid contact between the hand and the test sample.

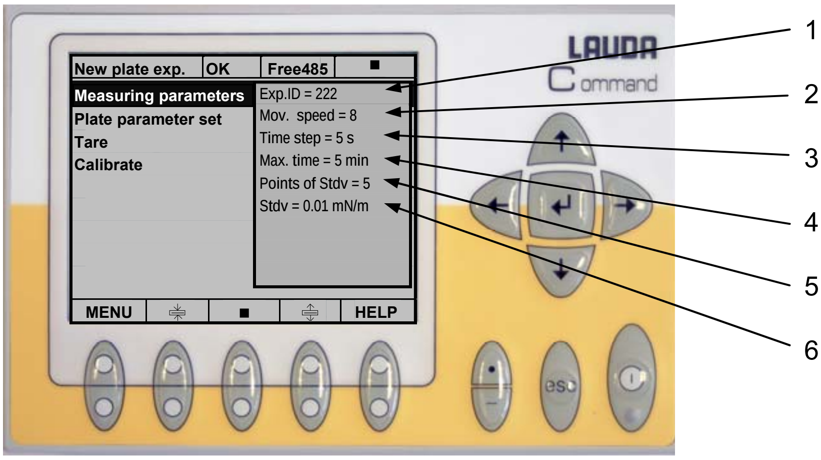
4. Place the sample container with sufficient sample liquid for taring on the sample table in the recess provided for it.

☞	When using the PTT Peltier Thermostating Unit place it on the sample table in the position provided and put the sample container in position.

5.1.2 Checking and setting the Wilhelmy plate data

5.1.2.1 Entering the measuring parameters

Main menu	⟹	Experiment new	⟹	New plate exp.	⟹	Measuring parameters
					⟹	Plate parameter set



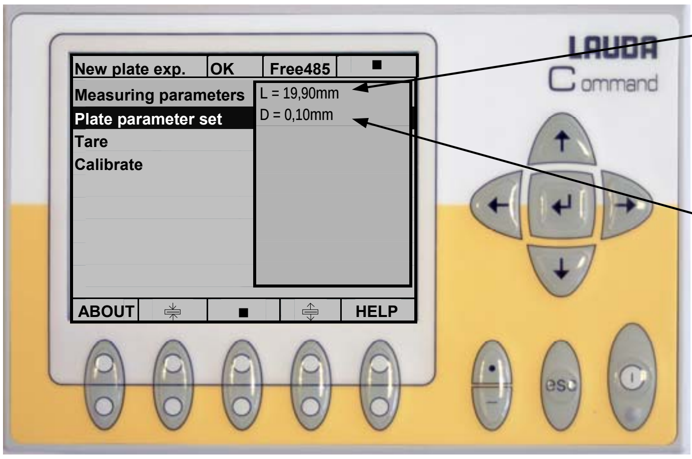
1. **Experiment ID**
   Sequence of figures for clear identification of sample.
2. **Mov. speed**
   Speed at which the sample table is raised, (1...10)

☞	Normally, max. speed is used during plate measurement.

3. **Time step**
   Pause time between individual measurements (1...250) s
4. **Max. time**
   Maximum measurement duration; once it has expired the measurement stops automatically and evaluation occurs.
5. **Points of Stdv**
   Specification of the number of the last measured values for determining the standard deviation.
6. **Stdv**
   Specification of the admissible standard deviation for the last measured points. When this value is undercut, the measurements are regarded as stable. The measurement is terminated.

☞	Normally, a value of 0.1mN/m should be obtained.

5.1.2.2 Entering plate parameters (geometrical data)



l
Enter the exact length of the Wilhelmy plate.

Range: (10…30) mm.

d
Enter the exact thickness of the Wilhelmy plate.

Range: (0.05…0.1) mm.

The displayed, default values correspond to the Wilhelmy plate available as an accessory. (⇨ 8.5.1)

This corresponds to DIN 53914.

☞	The value last set is saved.

5.1.3 Taring

The weight of the Wilhelmy plate must be tared again before the first measurement and after every change of test probe and measurement mode.

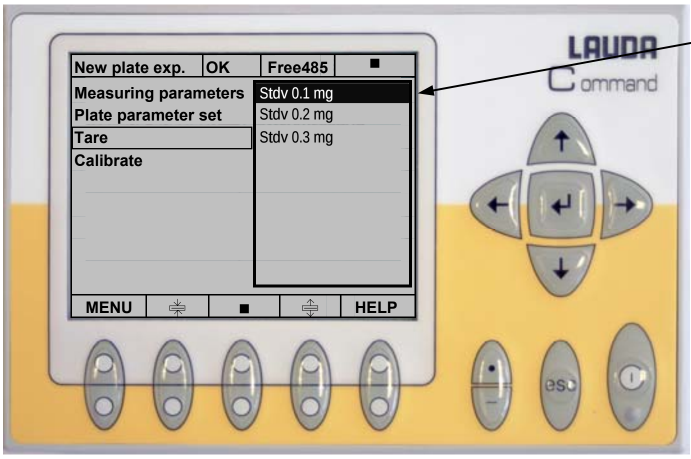
Main menu	⟹	Experiment new	⟹	New plate exp.	⟹	Tare	⟹

Measurement of surface tension:

☞	Tare the freely suspended plate.

Measurement of interfacial tension:

☞	Tare the plate completely immersed in the lighter phase.



Stdv

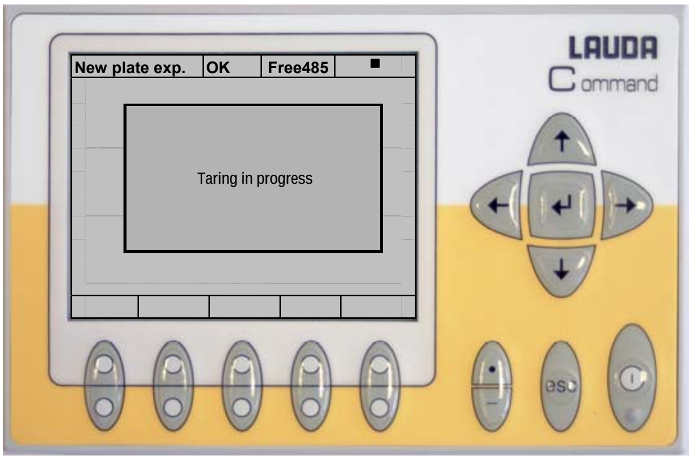
Standard deviation of taring.

This value defines the required taring stability.

The deviation must not be greater than the set value during the plate measurement.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

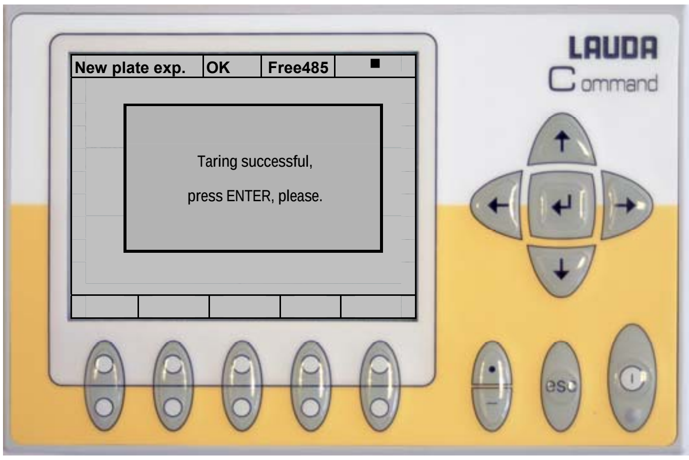
☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Taring in progress

The weight measurement for taring is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



Taring successful

Confirm with ↵.

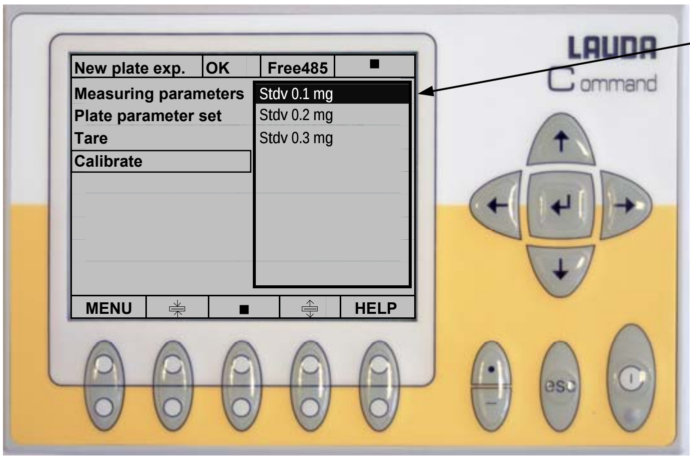
Taring can be interrupted with esc.

5.1.4 Calibration

The load cell should be calibrated before the first measurement and after every change of test probe and measurement mode.

Main menu	⟹	Experiment new	⟹	New plate exp.	⟹	Calibrate	⟹	

☞	The test probe and calibrating weight must hang freely.



Stdv

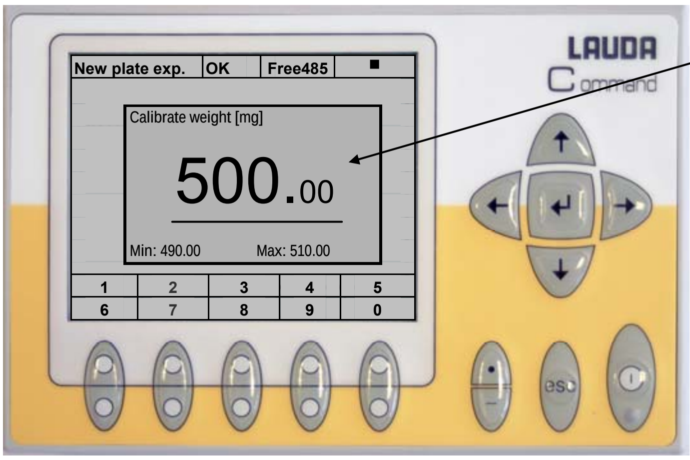
Standard deviation of calibration.

This value defines the required calibration stability.

The deviation must not be greater than the set value during the measurement of the plate and the calibrating weight.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Calibrating weight, mg:

Enter specified or separately determined calibrating weight.

The individual figures can be selected with the cursor keys ← → and

changed using the corresponding

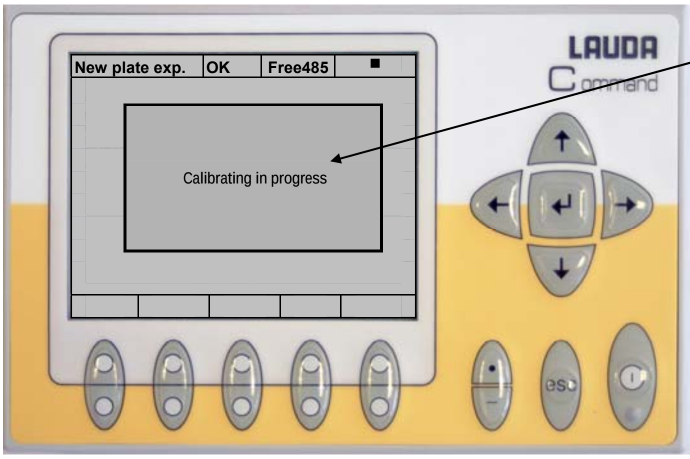
soft key.

Carefully suspend the calibrating weight in addition to the Wilhelmy plate.

Confirmation with ↵ starts the calibration.

The weight of the stirrup may deviate slightly from the nominal value of 500 mg (max. ± 1 mg). If an accuracy of < 1mg is required, precise determination by means of a semi-microbalance is necessary.

Tolerance range of the supplied calibrating weights is between 490 and 510 mg.

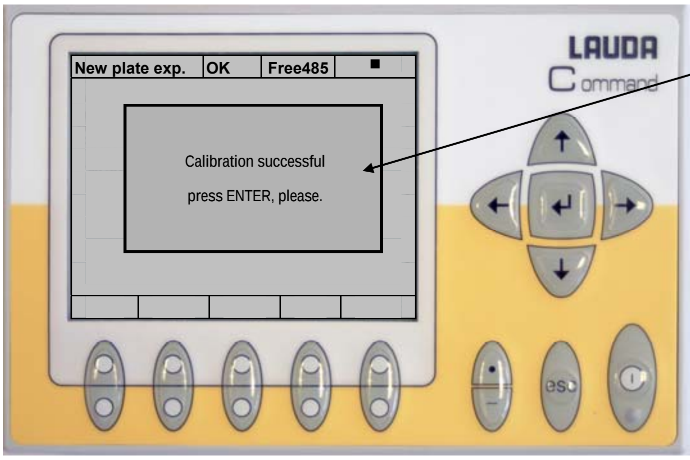


Calibrating in progress

The weight measurement for calibration is running.

Do not disturb or interrupt this process.

Avoid vibrations and mechanical shocks.



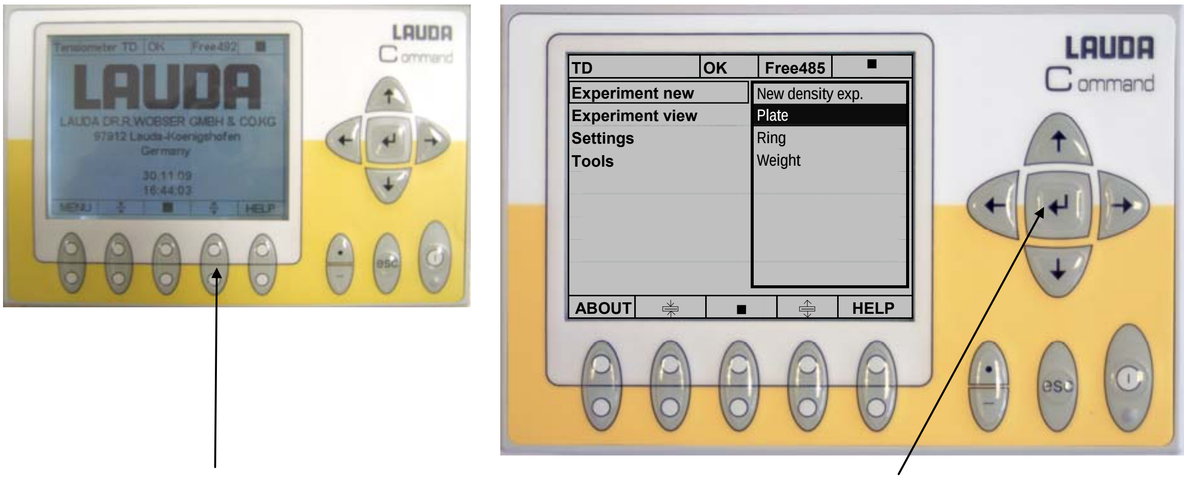
Calibration successful

Confirm with ↵.

Calibration can be interrupted with esc.

Carefully remove the calibrating weight.

5.1.5 Measurement with the Wilhelmy plate



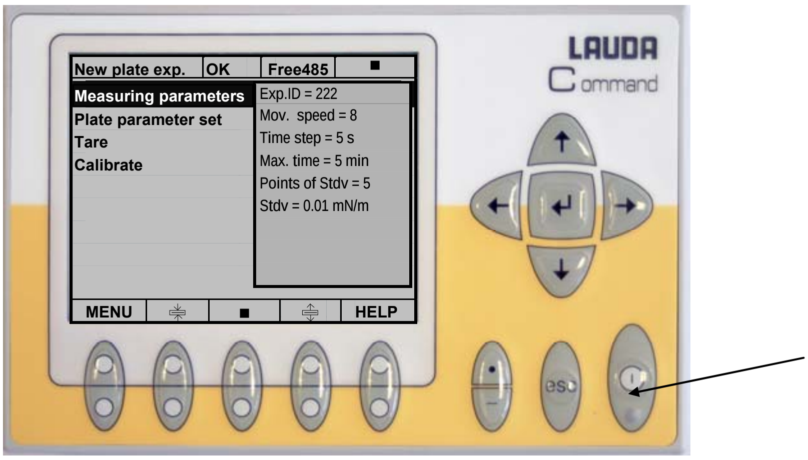
1 2

1. Lower the sample table with the soft key ,

   Put the beaker with the sample in position.

☞	The plate must not contact the sample.

2. Experiment new, confirm plate measurement with .
3. Check and adapt the measuring parameters.



4

4. Start the measurement with ; the LED lights up.

The sample table moves upwards at the set speed until the sample contacts the plate. The transducer detects the contact with the liquid and stops the motor.

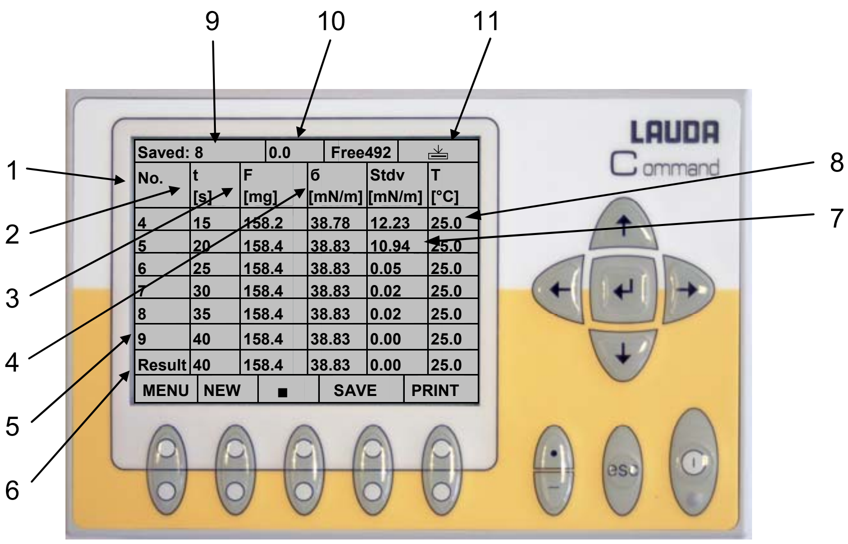
In the display the first measurement appears - the absolute surface tension in mN/m.

The measurement is repeated in predefined time steps and entered into the list until either the required measurement stability has been obtained or the maximum measurement duration has been exceeded.

> The value is correct when the meniscus has formed uniformly over the complete plate length on both sides and exhibits no significant indentations or gaps.

> With the interfacial tension measurement the lighter phase must be carefully covered over directly after stopping the motor until the plate is completely immersed. The displayed force reduces and corresponds to the interfacial tension.

Display during the measurement



1. Measurement point
2. Measurement duration [s]
3. Force [mg]
4. Surface tension or interfacial tension [mN/M]
5. Display of the current measurement series.

6. Result of the measurement series

7. Standard deviation of the defined measurement points

8. Indication from the external temperature sensor or temperature of the PTT Peltier Thermostating Unit.

☞	If no thermometer is connected, the field remains blank.

9. Number of saved measurement series

10. Currently measured weight.

11. Status of the sample table

☞	Once the measurement has finished, the static surface or interfacial tension is determined from the defined measurement points as the result and entered into the next row of the table (6) together with the measurement duration and standard deviation. These values can be temporarily saved together with the measuring parameters or output to a protocol printer.
☞	If a printout of the measurement series is needed, this can be obtained using "Print all values" (⇨ 4.4.6.9) during the measurement.

5.2 Measuring with the du Noüy ring

5.2.1 Measurement preparation

1. Switch on the TD 3 by the on/off switch on the external power supply unit.
2. Using the soft key or move the sample table into a central position or, if using the PTT Peltier Thermostating Unit, the lowest position. Make sure there is sufficient space for changing the sample beaker and for suspending the du Noüy ring.
3. Freely suspend the du Noüy ring on the hook of the measurement system.

	Use tweezers - it is essential to avoid contact between the hand and the test sample.

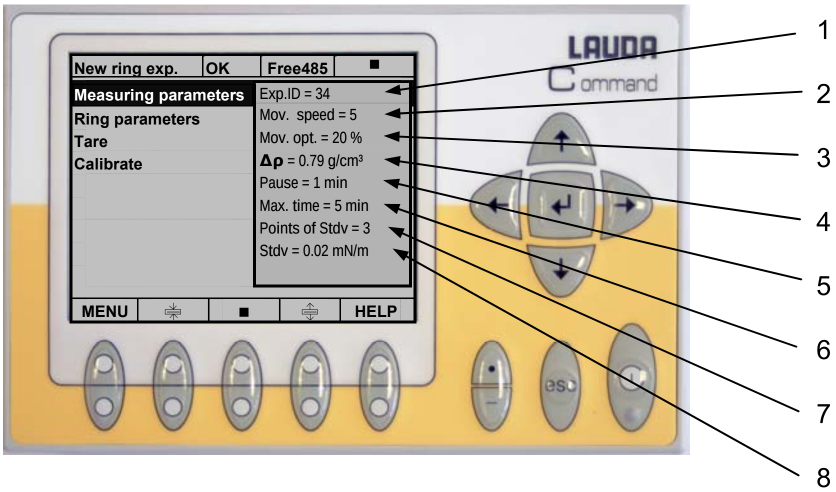
4. Place the sample container with sufficient sample liquid for taring on the sample table in the recess provided for it.

	When using the PTT Peltier Thermostating Unit, place it on the sample table in the position provided and put the sample container in position.

5.2.2 Checking and setting the ring parameters

5.2.2.1 Entering the measuring parameters

Main menu	⟹	Experiment new	⟹	New ring exp.	⟹	Measuring parameters
					⟹	Ring parameters



1. **Experiment ID**
   Sequence of figures for clear identification of sample.

2. **Mov. Speed**
   Speed at which the sample table is raised, (1...10)

☞	Appropriate slow movement is needed to avoid viscosity effects. In the viscosity range 0.5 – 5 mm²/s good results are generally obtained with the value 5.

3. **Mov. opt.**
   Defines how far the ring is withdrawn after detecting the force maximum.

   Example:
   Here, after detecting the first maximum the ring is moved back until 20% of the maximum force is reached. The ring remains above the level of the interface until the next extraction is started after the specified pause time. On entering 100% the ring moves back completely to the interface.

☞	In 90% of cases the set value of 20% leads to good measurement results. With wetting problems (e.g. premature laminar separation) change it appropriately.

4. $\Delta\rho$
   Density of the sample or with the measurement of interfacial tension the density difference between the phases. It is required for ring correction.

☞	For aqueous solutions at 20°C the value of 0.99 g/cm³ is applicable. An accuracy of ± 0.01 is sufficient.

5. **Pause**
   Pause time between two measurement points.
   Adjustment range: (1...120) min.

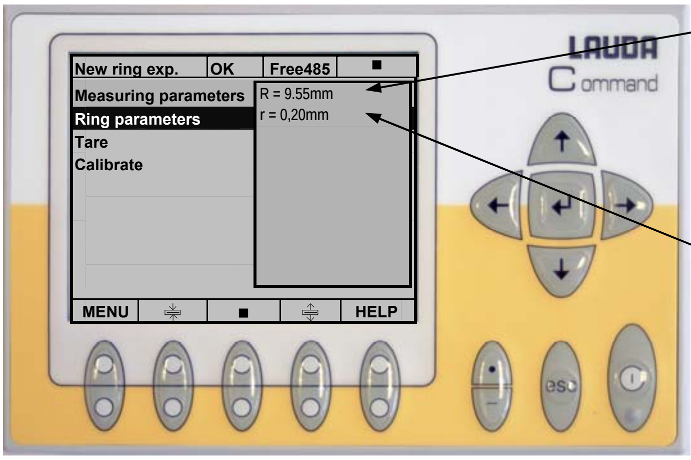
6. **Max. time**
   Maximum duration of the measurement.
   Adjustment range: (1…255) min.

7. **Points of Stdv**
   Specifies the number of the last measured values for determining the standard deviation.

8. **Stdv**
   Specifies the admissible standard deviation for the last measured points. When this value is undercut, the measurements are regarded as stable. The measurement is terminated.

☞	Normally, a value of 0.1 mN/m should be obtained.

5.2.2.2 Entering ring parameters (geometrical data)



R
The exact radius (= half the diameter referred to the centre of the wire) of the du Noüy ring.

Range: (9.00…9.99) mm.

r
The exact radius of the ring wire.

Range: (0.10…0.30) mm.

The displayed default values correspond to the size of the supplied du Noüy ring. This corresponds to DIN 53914.

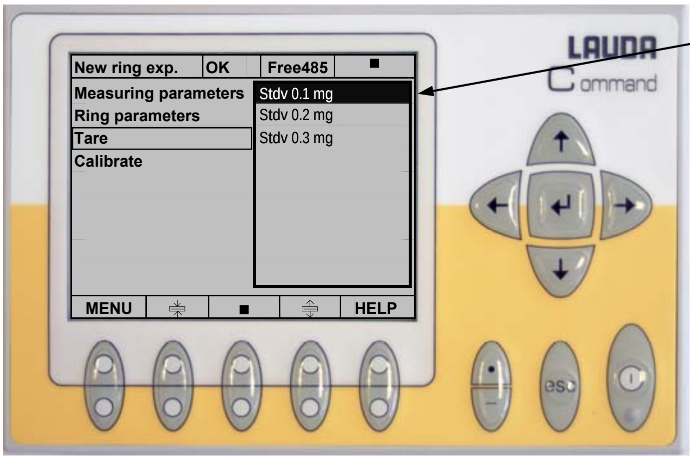
☞	The value last set is saved.

5.2.3 Taring

The weight of the ring must tared again before the first measurement and after every change of test probe and measurement mode.

Main menu	⟹	Experiment new	⟹	New ring exp.	⟹	Tare	⟹

☞	Tare the freely suspended ring.



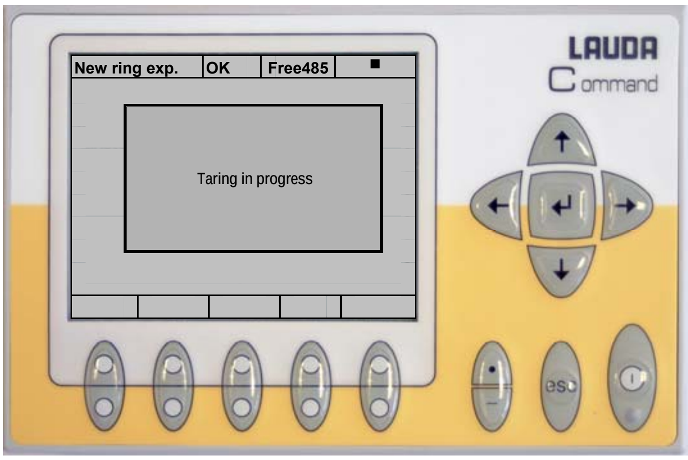
Stdv
Standard deviation of taring.

This value defines the required taring stability.

The deviation must not be greater than the set value during the ring measurement.

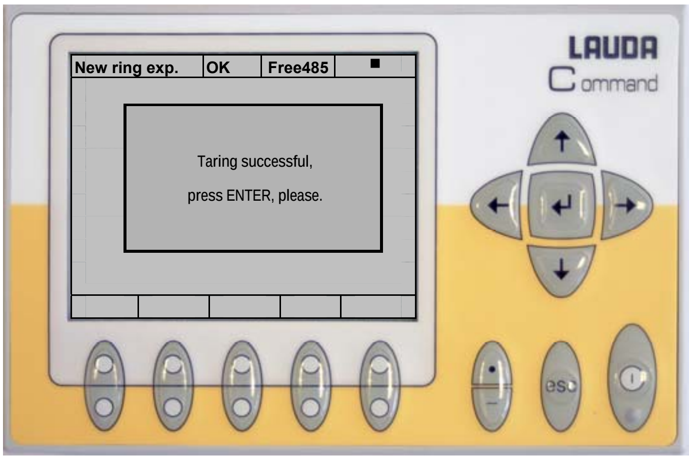
The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Taring in progress
The weight measurement for taring is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



Taring successful

Confirm with .

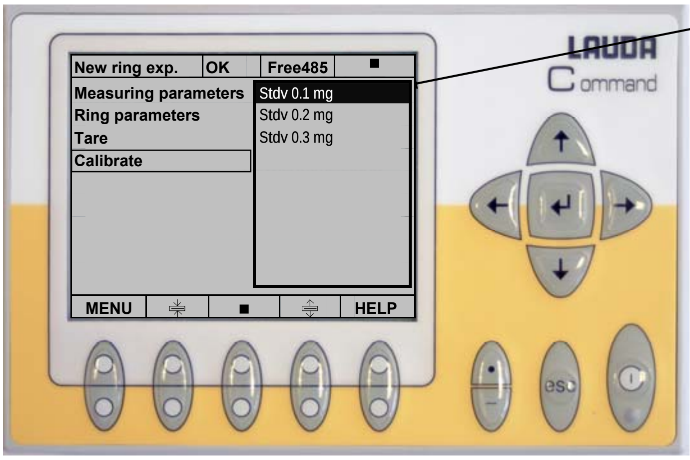
Taring can be interrupted with .

5.2.4 Calibration

The load cell should be calibrated before the first measurement and after every change of test probe and measurement mode.

Main menu	⟹	Experiment new	⟹	New ring exp.	⟹	Calibrate	⟹

☞	Calibration occurs in a sample liquid with exactly known density. Calibration in pure water has been well proven.



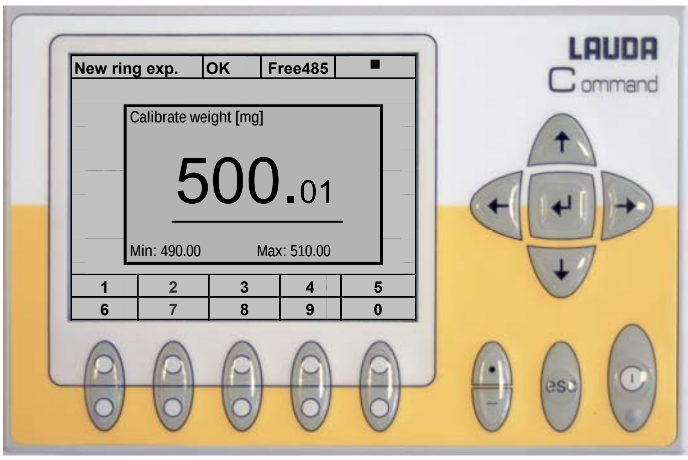
Stdv Standard deviation of calibration.

This value defines the required calibration stability.

The deviation must not be greater than the set value during the measurement of the ring and the calibrating weight.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Calibrate weight, mg:

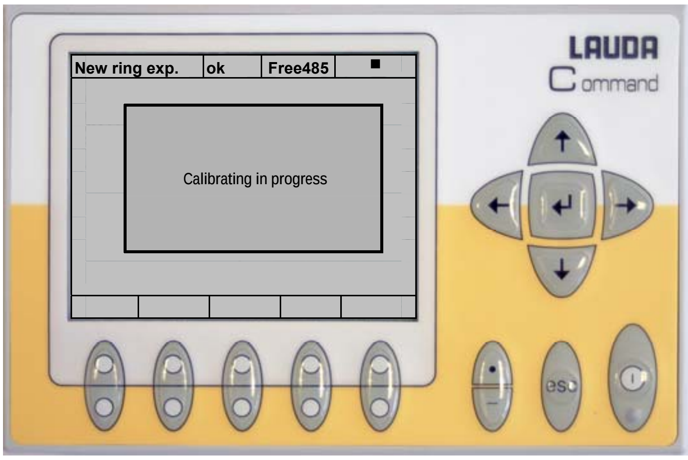
Enter specified or separately determined calibrating weight.

The individual figures can be selected with the cursor keys ← → and changed using the corresponding soft key.

☞	Carefully suspend the calibrating weight in addition to the ring.

Confirmation with ↵ starts the calibration.

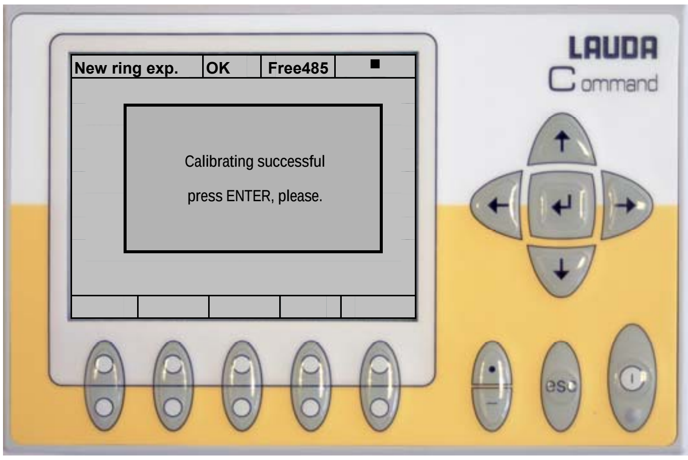
☞	The test probe and calibrating weight must hang freely.
☞	The weight of the stirrup may deviate slightly from the nominal value of 500 mg (max. ± 1 mg). If an accuracy of < 1mg is required, precise determination by means of a semi-microbalance is necessary. The tolerance range for the supplied calibrating weights is limited to 490 – 510 mg.



Calibrating in progress

The weight measurement for calibration is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



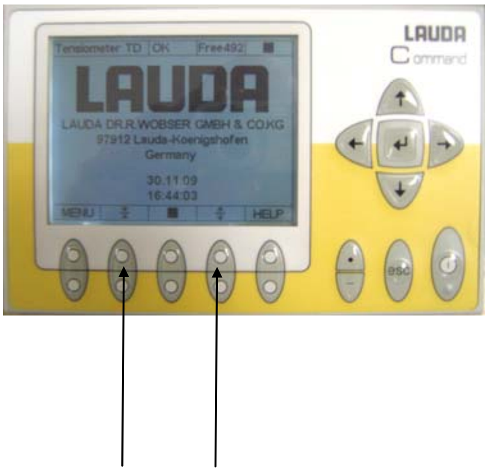
Calibrating successful

Confirm with ↵.

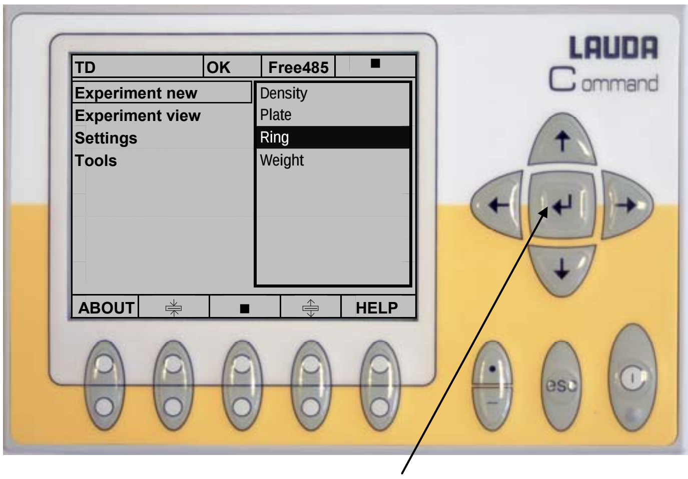
Carefully remove the calibrating weight.

Calibration can be interrupted with esc.

5.2.5 Measuring with the du Noüy ring



3 1

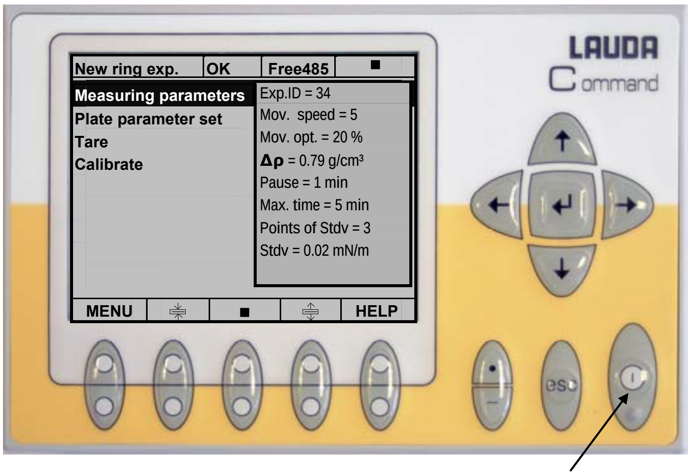


2

1. Lower sample table.
Put the beaker with the sample in position.

☞	The test probe and calibrating weight must hang freely.

2. Experiment new, confirm plate measurement with ↵.
Check and adapt the measuring parameters.



4

3. Move the sample table upwards at the set speed until the adjustable upper lifting limit of the sample table (⇨ 3) switches the movement off. This limit must be set such that the ring dips into the sample liquid by approx. 2 mm.

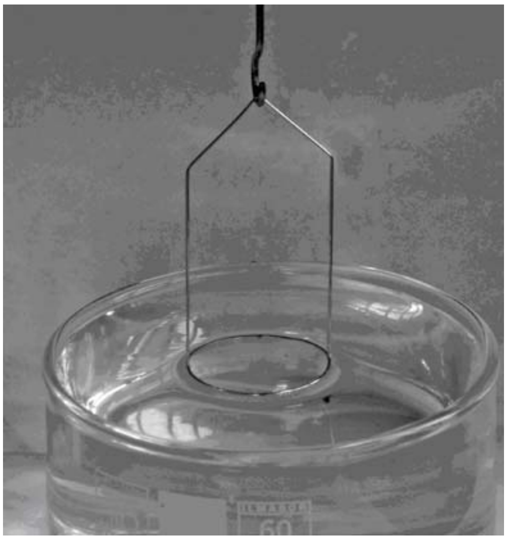
If the ring is insufficiently wetted, the ring may float. In this case it must be cleaned thoroughly and the process repeated.

4. Start the measurement with ; the LED lights up.

5. The sample table moves downwards and the ring is withdrawn from the sample. The lamella forms on withdrawal from the liquid. In doing this the force continually increases until the force maximum is reached.

The display shows the first measurement, the maximum force in mg, the time after the start of the measurement, as well as the surface or interfacial tension derived from it and then corrected.

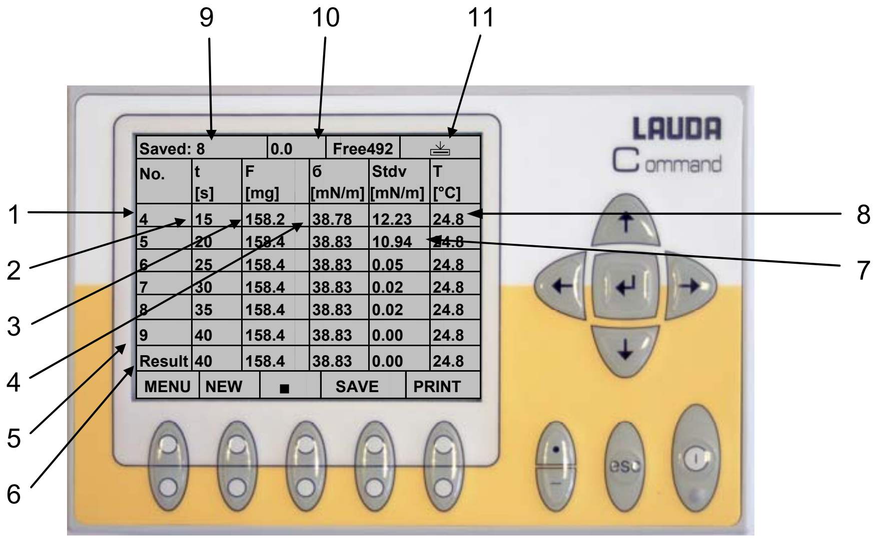
The measurement is repeated in predefined time steps and the individual measurement points entered into the list until either the required measurement stability has been obtained or the maximum measurement duration has been exceeded.



☞	The value is correct when the meniscus forms uniformly over the complete ring.

☞	With interfacial tension measurement the sample container is initially only half filled with the lower phase . Before starting the measurement with the immersed ring, carefully cover the lighter phase up to a thickness of approx. 15mm without the measuring ring coming into contact with the upper phase.

Measurement display



1. **Measurement point**
   This corresponds to the number of detected and evaluated force maxima.
2. Measurement duration [s].
3. Force [mg].
   Corresponds to the maximum force.
4. Corrected surface tension or interfacial tension [mN/M]
5. Display of the current measurement series.
6. Result of the measurement series
7. Standard deviation of the defined measurement points
8. Display of external temperature sensor or temperature of the PTT.
   No sensor will result in a blank column.
9. Number of saved measurement series
10. Currently measured weight.
11. Status of the sample table

Once the measurement has finished, the static surface or interfacial tension is determined from the defined measurement points as the result and entered into the next row of the table (6) together with the measurement duration and standard deviation. These values can be temporarily saved together with the measuring parameters or output to a protocol printer.

☞	If a printout of the measurement series is needed, this can be obtained using "Print all values" (⇨ 4.4.6.9) during the measurement.

5.2.6 Correcting the measurement

In contrast to the Wilhelmy method the force measured using the du Noüy method does not correspond directly to the surface or interfacial tension, because on withdrawing the ring the weight of the liquid withdrawn together with the lamella has to be taken into account. With a known density (difference) this effect can be corrected. With the TD 3 this is automatically taken into account as a correction according to Zuidema & Waters. The given measurements are absolute and do not need to be revised.

Further information on correcting the ring measurement can be found in the references listed in the appendix (10, 20, 21, 22). (⇨ 8.6)

6 Measurement of density and weight

6.1 Density measurement

6.1.1 Measurement preparation

1. Switch on the TD 3 by the on/off switch on the external power supply unit.

2. Using the soft key or move the sample table into a central position or, if using the PTT Peltier Thermostating Unit, the lowest position. Make sure there is sufficient space for changing the sample beaker and for suspending the displacement body.

3. Freely suspend the displacement body on the hook of the measurement system.

The displacement body must be clean and dry and must not contact the sample.

☞	Use tweezers - it is essential to avoid contact between the hand and the test sample.

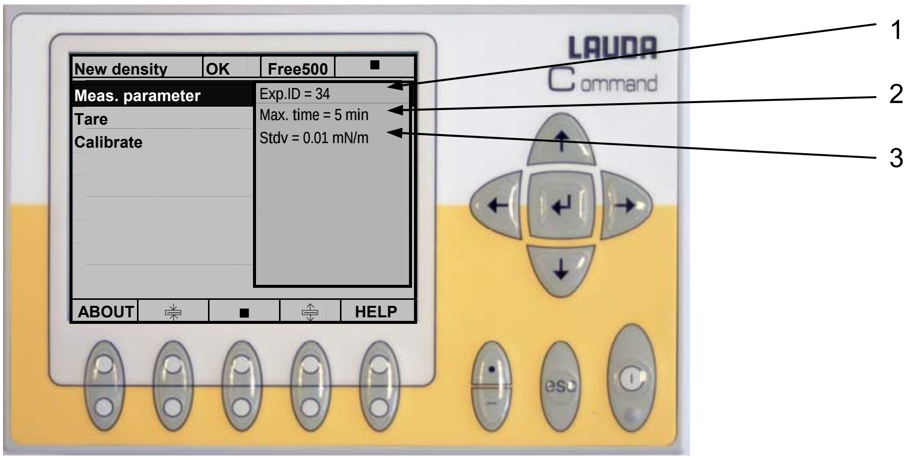
4. Place the sample container with sufficient sample liquid on the sample table in the recess provided for it.

☞	The sample to be measured must be poured into the sample container to a level at which the displacement body can be completely immersed in the sample without contacting the bottom of the container. When using the PTT Peltier Thermostating Unit place it on the sample table in the position provided and put the sample container in position.

6.1.2 Checking and setting the measuring parameters

Entering the measuring parameters

Main menu ⟹ Experiment new ⟹	New density exp.	⟹ Measuring parameters



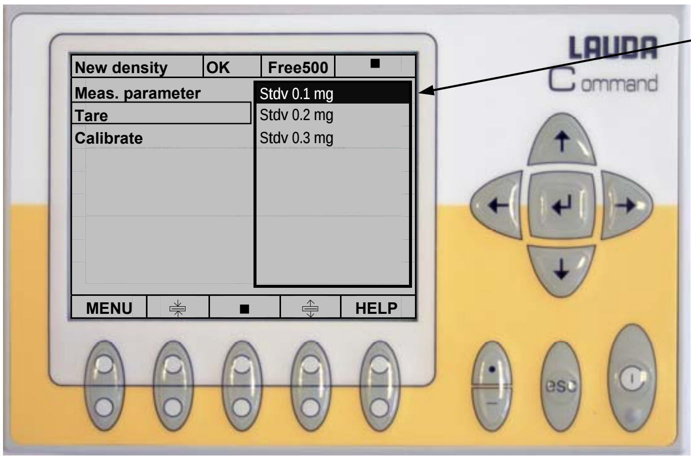
1. **Experiment ID**
   Sequence of figures for clear identification of sample.
2. **Max. time**
   Maximum duration of the measurement.
3. **Stdv**
   Specification of the admissible standard deviation for the last measured points. When this value is undercut, the measurements are regarded as stable. The measurement is terminated.

6.1.3 Taring

The test probe must tared again in air before the first measurement and after every change of test probe and measurement mode.

Main menu	⟹	Experiment new	⟹	New density exp.	⟹	Tare	⟹

☞	Tare the freely suspended displacement body.



Stdv

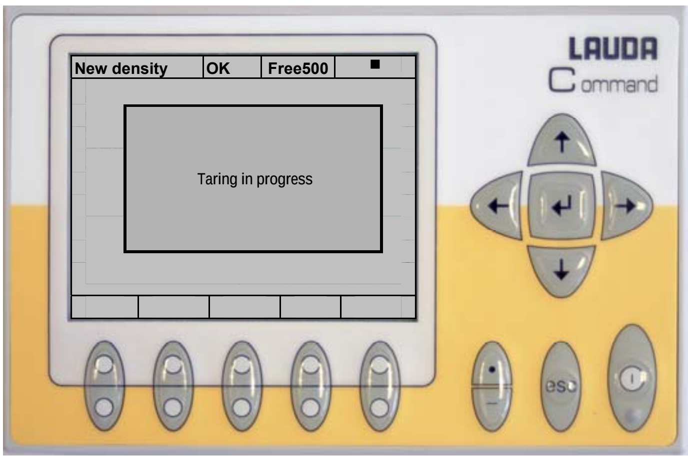
Standard deviation of taring.

This value defines the required taring stability.

The deviation must not be greater than the set value during the measurement of the buoyancy probe.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

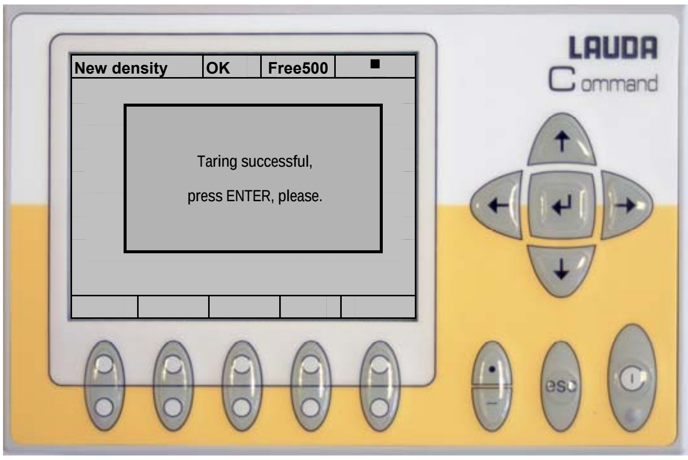
☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Taring in progress

The weight measurement for taring is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



Taring successful

Confirm with .

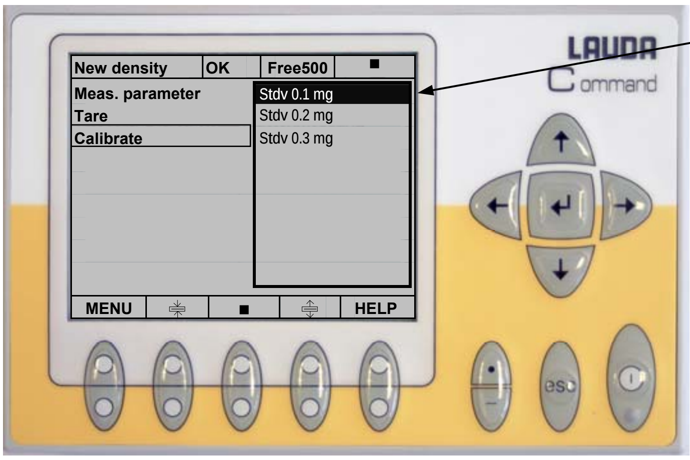
Taring can be interrupted with .

6.1.4 Calibration

The load cell should be calibrated before the first measurement and after every change of test probe and measurement mode.

Main menu	⟹	Experiment new	⟹	New density exp.	⟹	Calibrate	⟹

☞	Calibration occurs in a sample liquid with exactly known density. Calibration in pure water has been well proven.



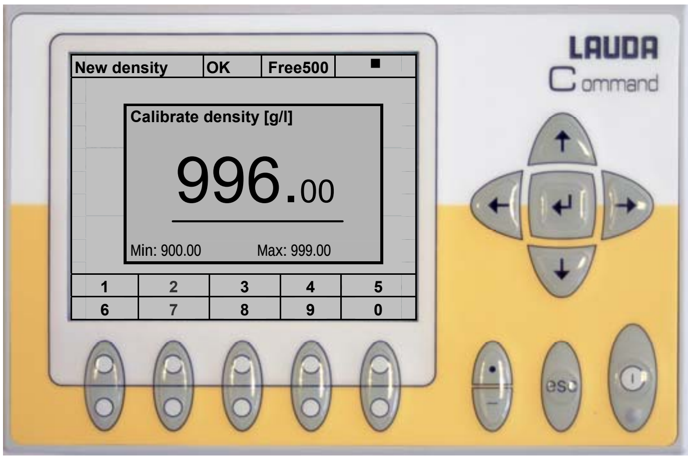
Stdv
Standard deviation of calibration.

This value defines the required calibration stability.

The deviation must not be greater than the set value during the measurement of the plate and the calibrating weight.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Density of the calibration liquid, [g/l]

Enter the specified or separately determined density of the reference liquid.

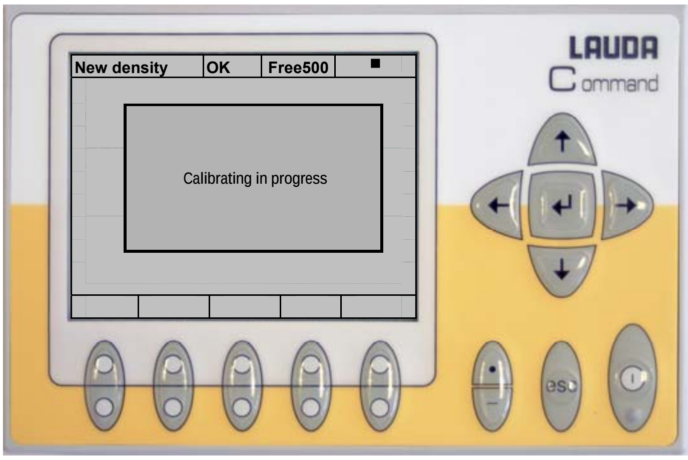
The individual figures can be selected with the cursor keys ← → and changed using the corresponding soft key.

Temperature [°C]	Density [g/l]
15	998
16 - 22	997
23 - 26	996
27 - 29	995
30 - 33	994
33 - 35	993

This table shows the most used density figures for pure water. It is sufficient to specify three significant places.

Confirmation with ↵ starts the calibration.

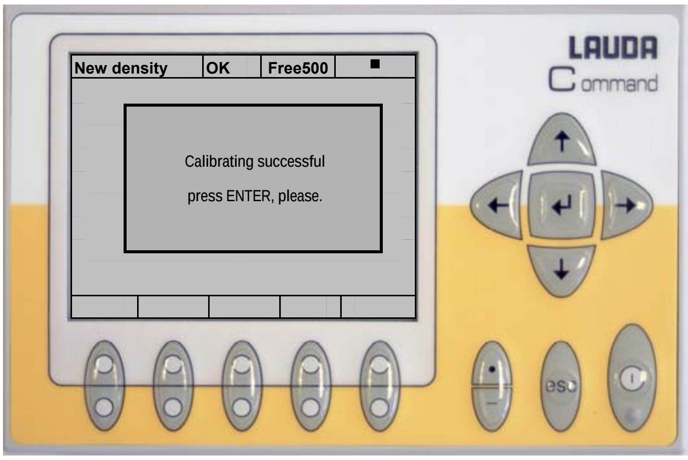
☞	The tared test probe must hang freely and be completely immersed in the calibration liquid.



Calibrating in progress

The weight measurement for calibration is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



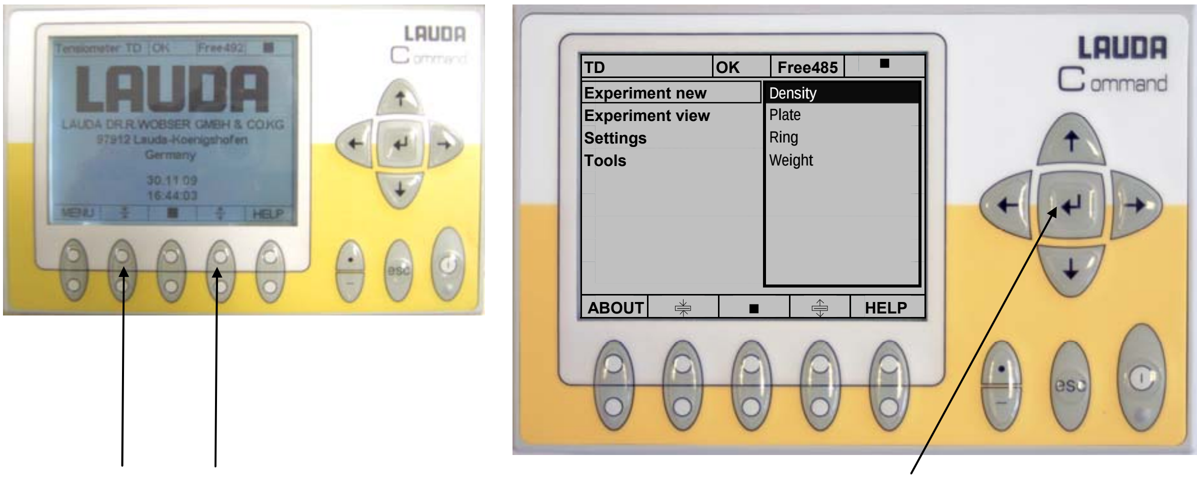
Calibrating successful

Confirm with ↵.

Carefully remove the calibrating weight.

Calibration can be interrupted with esc.

6.1.5 Measuring the density with the buoyancy probe



2 1 3

1. Lower sample table.
   Put the beaker with the sample in position.

☞	Clean and dry the displacement body and suspend it again.

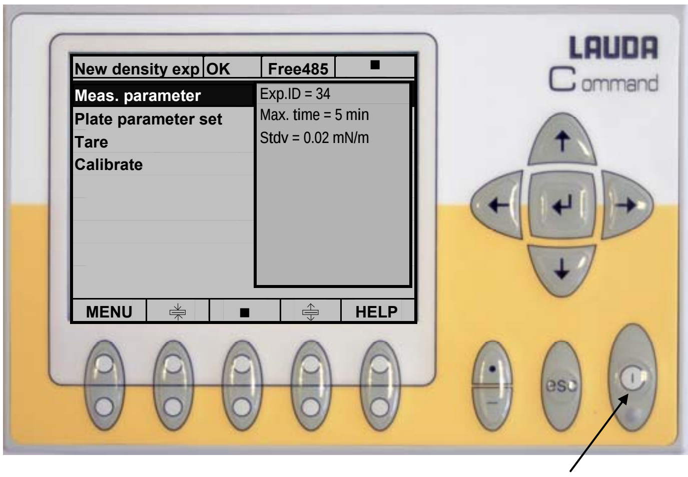
2. Raise the sample table until the buoyancy probe is completely immersed.

☞	The tared test probe must hang freely and be completely immersed in the test liquid.

3. Experiment new, confirm density measurement with ↵.

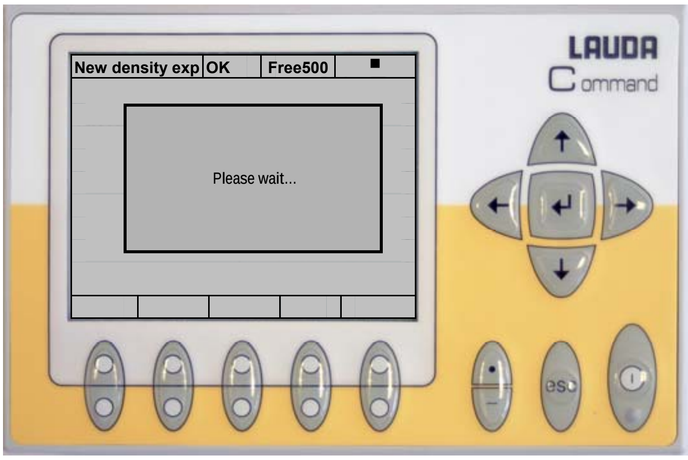
Check and adjust the measuring parameters.

4. Start the measurement with ; the LED lights up.



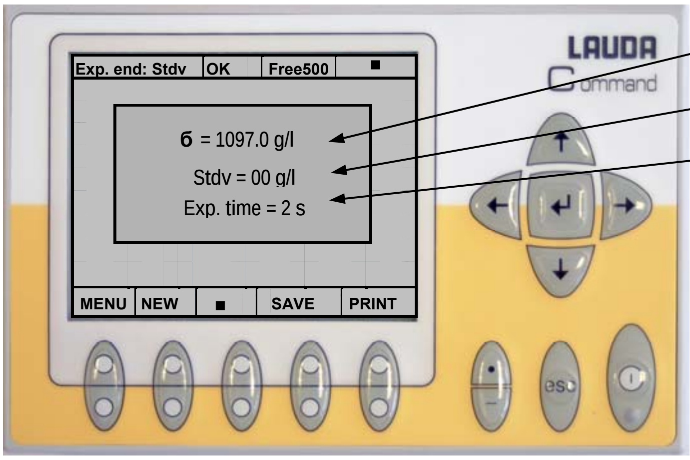
4

Display during the measurement



100 measurements are recorded in a time period of 2 seconds and the standard deviation determined.

The measurement is repeated in predefined time steps until either the required measurement stability has been obtained or the maximum measurement duration has been exceeded.



1
2
3

1. The density is found from the mean of the buoyancy force measurements in the last 2 seconds.
2. Standard deviation of the measurement series used.
3. Experiment time.

☞	The result can be temporarily saved together with the measuring parameters or output to a protocol printer.

6.2 Weight measurement

6.2.1 Measurement preparation

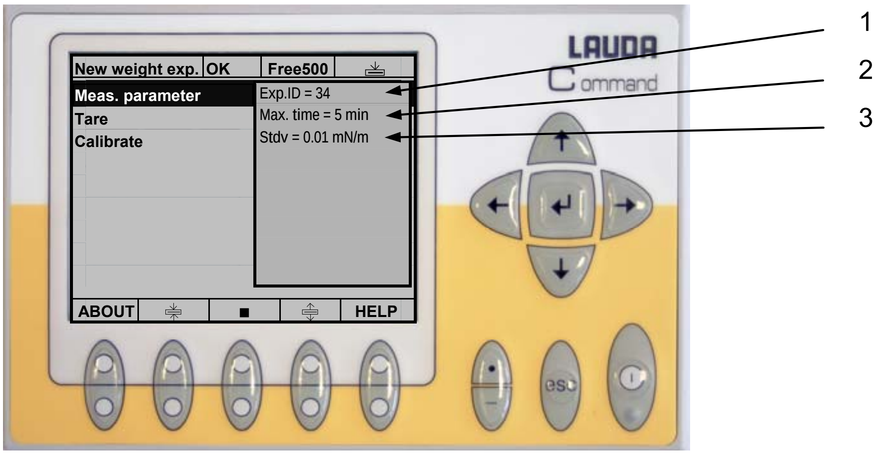
1. Switch on the TD 3 by the on/off switch on the external power supply unit.
2. Move the sample table into the lowest position using the soft key. Push the adjustable lower lifting limit on the sample table completely downwards.
3. Fit the sample directly or with a suitable sample holder to the hook of the measurement system.

☞	The total weight of the holder and sample must not exceed 5 g.

6.2.2 Checking and setting the measuring parameters

Entering the measuring parameters

Main menu	⟹	Experiment new	⟹	New weight exp.	⟹	Meas. parameter



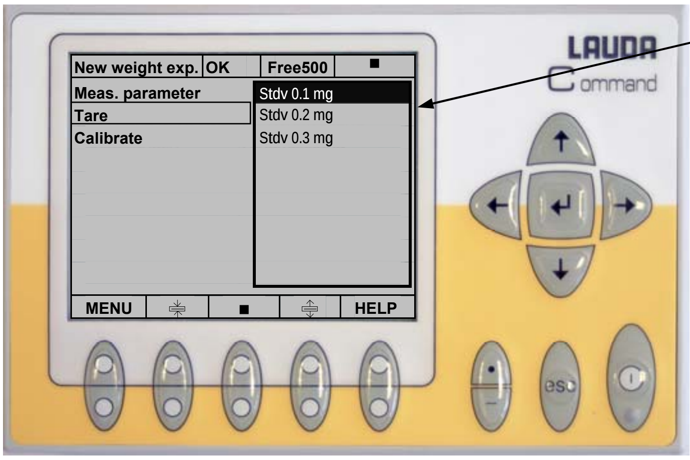
1. **Experiment ID**
   Sequence of figures for clear identification of sample.
2. **Max. time**
   Maximum duration of the measurement.
3. **Stdv**
   Specification of the admissible standard deviation for the last measured points. When this value is undercut, the measurements are regarded as stable. The measurement is terminated.

6.2.3 Taring

The weight of the hook and, if used, that of the sample holder must be tared before the first measurement and after each change of measurement mode.

Main menu	⟹	Experiment new	⟹	New weight exp.	⟹	Tare	⟹

☞	Suspend hook freely and hook on sample holder.



Stdv

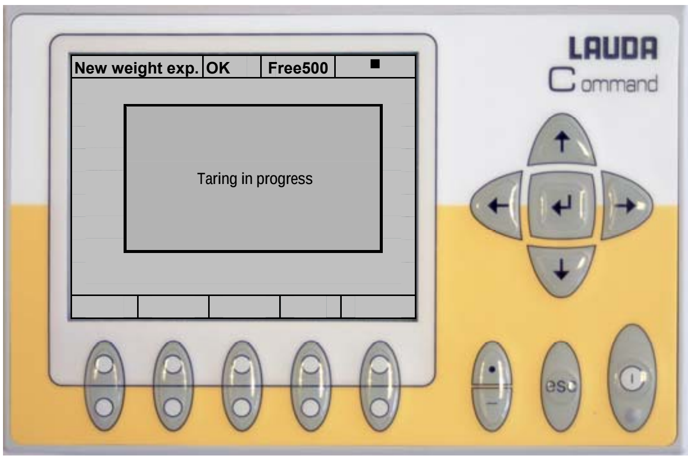
Standard deviation of taring.

This value defines the required taring stability.

The deviation must not be greater than the set value during the measurement.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

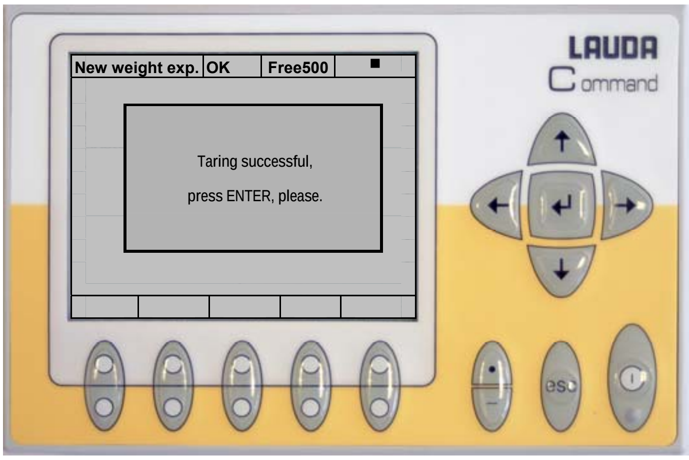
☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Taring in progress

The weight measurement for taring is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



Taring successful

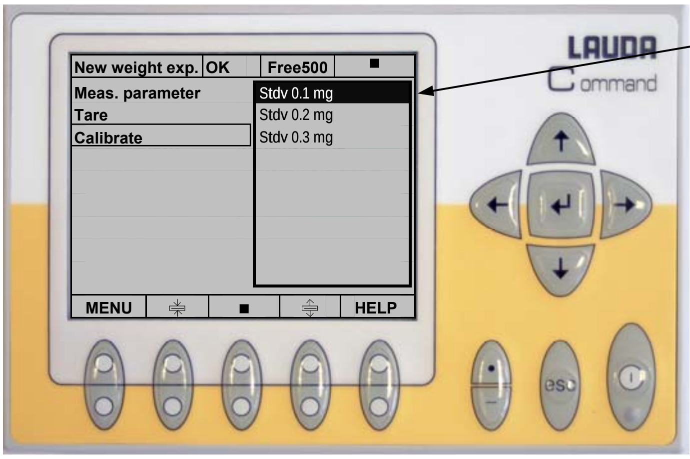
Confirm with ↵.

Taring can be interrupted with esc.

6.2.4 Calibration

The load cell should be calibrated before the first measurement and always when the test probe is changed.

Main menu	⇒	Experiment new	⇒	New weight exp.	⇒	Calibrate	⇒



Stdv

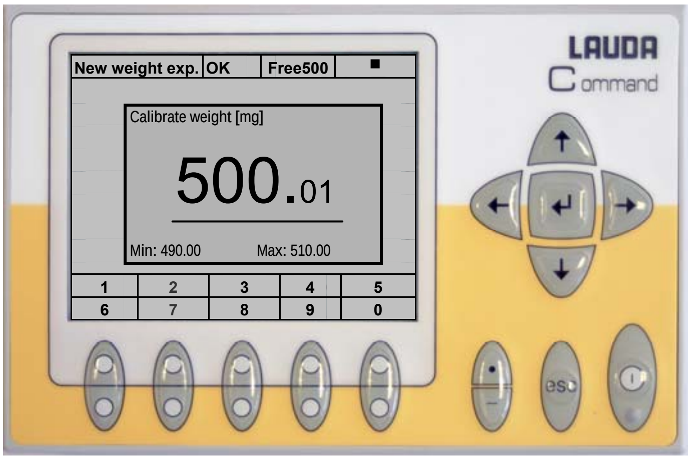
Standard deviation of calibration.

This value defines the required calibration stability.

The deviation must not be greater than the set value during the measurement of the calibrating weight.

The time period for the measurement extends from 2 s to a maximum of 10 s if the required deviation is not achieved.

☞	Generally, the highest accuracy of 0.1 mg should be the target value. It is only when this value cannot be obtained (e.g. in the case of external vibrations) that larger values should be chosen for the standard deviation. However, this reduces the accuracy and reproducibility of the following measurements.



Calibrating weight, mg

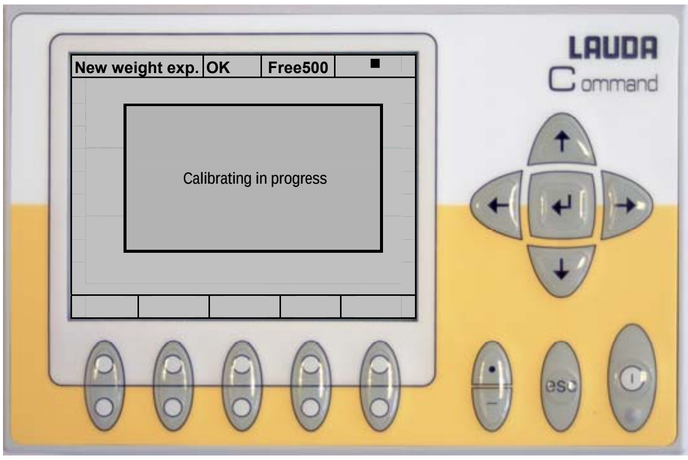
Enter specified or separately determined calibrating weight.

The individual figures can be selected with the cursor keys ← → and changed using the corresponding soft key.

☞	Carefully suspend the calibrating weight in addition to the sample holder.

Confirmation with ↵ starts the calibration.

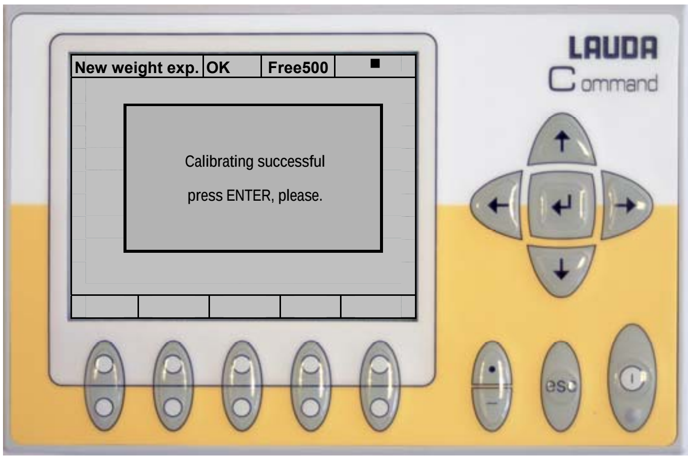
☞	The weight of the stirrup may deviate slightly from the nominal value of 500 mg (max. ± 1 mg). If an accuracy of < 1mg is required, precise determination by means of a semi-microbalance is necessary. The tolerance range for the supplied calibrating weights is limited to 490 – 510 mg.



Calibrating in progress

The weight measurement for calibration is running.

☞	Do not disturb nor interrupt this process. Avoid vibrations and mechanical shocks.



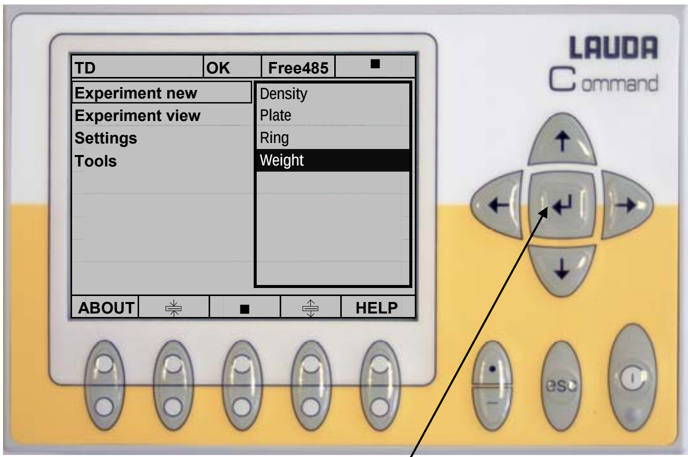
Calibrating successful

Confirm with ↵.

Carefully remove the calibrating weight.

Calibration can be interrupted with esc.

6.2.5 Weight measurement



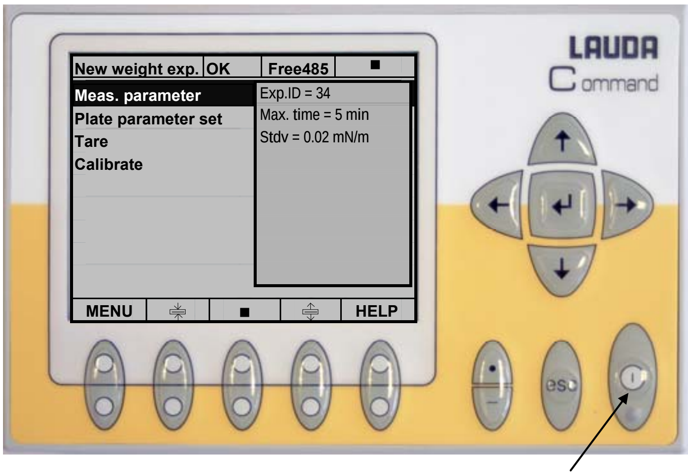
1 2

1. Lower sample table. Suspend test sample directly or with the sample holder.

2. Experiment new, Confirm weight measurement with .

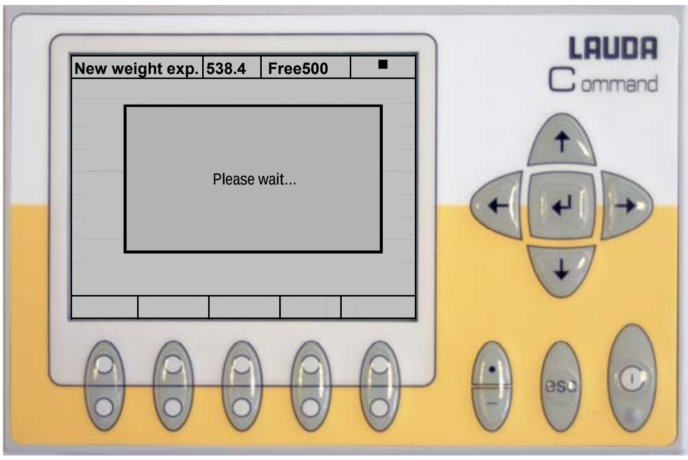
Check and adjust the measuring parameters.

3. Start the measurement with ; the LED lights up.



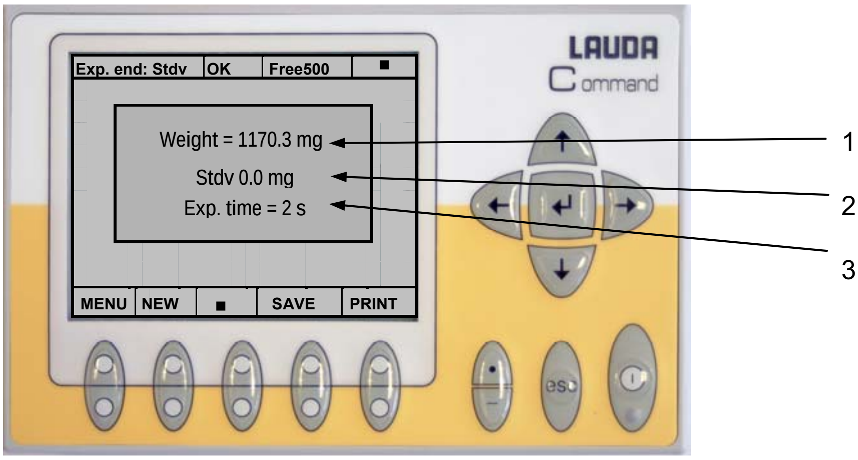
3

Display during the measurement



100 measurements are recorded in a time period of 2 seconds and the standard deviation determined.

The measurement is repeated in predefined time steps until either the required measurement stability has been obtained or the maximum measurement duration has been exceeded.



The following are displayed:

1. The weight is found from the mean of the measurements in the last 2 seconds.

2. Standard deviation of the measurement series used.

3. Experiment time.

☞	The result can be temporarily saved together with the measuring parameters or output to a protocol printer.

7 Displaying and outputting measurement results

7.1 Saving the measurement results

The measurement results can be saved in the COMMAND operating console. Depending on the setting (⇨ 4.4.6.8) saving occurs automatically after each measurement or manually.

In the COMMAND operating unit there is memory space for 500 measurements available.

With the optionally available data transfer software for PC / TD 2/3 the data can be transferred via the RS 232 interface on the COMMAND operating console and an optionally obtainable RS 232 connecting lead to a PC where the data can be saved.

7.2 Printing out measurement results

7.2.1 Connecting a printer

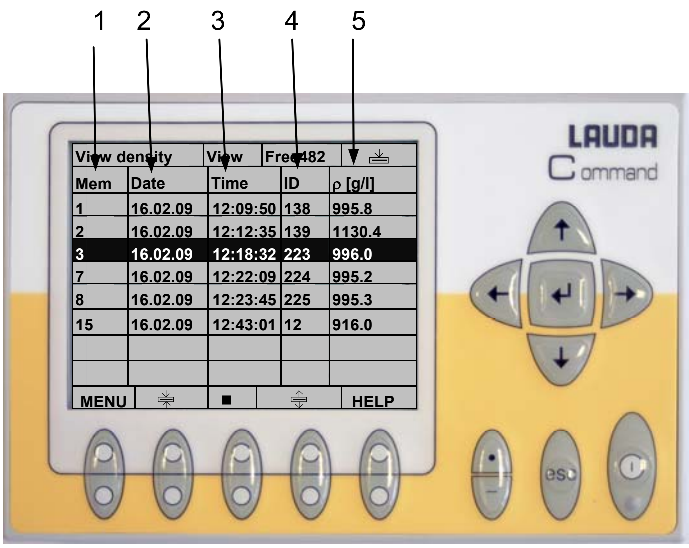
The measurement results can be printed out during or after the measurement on the protocol printer which is available as an accessory.

1. Unpack the printer and put it together.
2. Follow the operating instructions for the printer.
3. Switch off the TD 3.
4. Connect the RS 232 interface on the printer using the supplied RS 232 connecting lead to the corresponding socket which is located on the rear panel of the TD 3 and is labelled as a printer interface.
5. Check whether the switch on the printer is set to the "Off" position.

6. Connect the printer to a socket having a safety earth conductor.
7. Switch on the TD 3 using the switch on the external power supply unit.
8. Switch on the printer.
9. Check the printer settings (⇨ 4.4.6.10).

7.2.2 Density measurement

Main menu	⇒	Experiment view	⇒	Density measurement	⇒

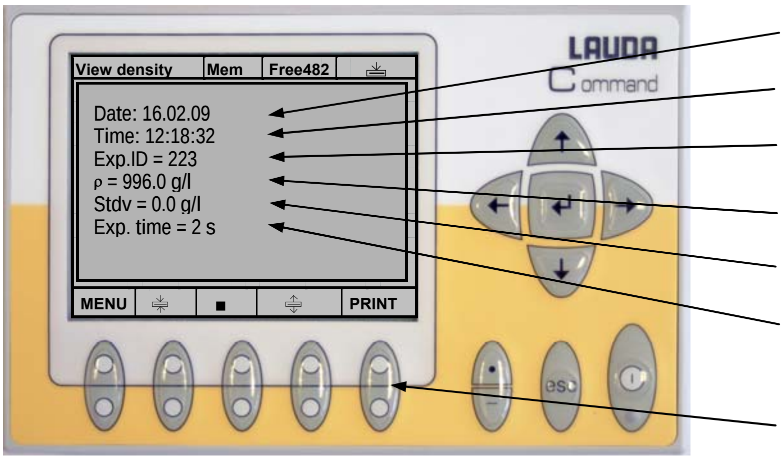


1. **Mem**
   Memory location of measurement results
2. **Date**
   Date of measurement, date of display (⇨ 4.4.6.7).
3. **Time**
   Time of the measurement.
4. **ID**
   Experiment ID (sample no.) (⇨ 6.1.2).
5. **ρ [g/l]**
   Measurement results in grams / litre.

If there are more than nine measurement results, the next page is displayed with →. ← pages back.

A single result can be selected with ↑ and ↓.

Confirm the measurement with ↵.



1 Date

2 Time of measurement

3 ID of measurement result

4 Measurement result

5 Standard deviation

6 Experiment time

7 Print out with

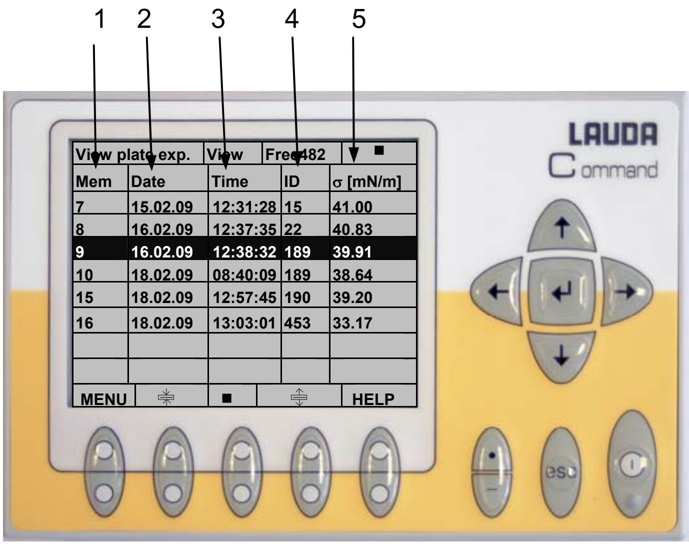
☞	The data cannot be changed retrospectively.

```
========================
LAUDA

Tensiometer TD3

------------------------------------------
Density measurement
16.02.09  12:18:32
Exp. ID = 223

Density = 996.0g/l
Stdv = 0.0 g/l
Exp. time = 2 s
------------------------------------------
Printed on 12.03.09  16:05:38
========================
```

The printout on the protocol printer contains all the data displayed in the detailed results window.

7.2.3 Plate measurement

Main menu	⇨	Experiment view	⇨	Plate measurement	⇨

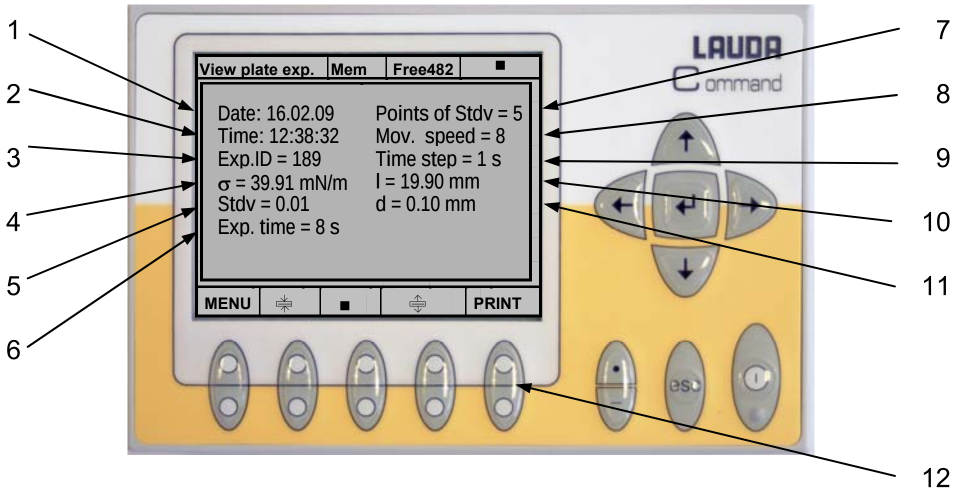


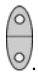
1. **Mem**
   Memory location of measurement results
2. **Date**
   Date of measurement, date of display (⇨ 4.4.6.7).
3. **Time**
   Time of the measurement.
4. **ID**
   Experiment ID (sample no.) (⇨ 5.1.2).
5. **σ [mN/m]**
   Measurement result in mN/m.

If there are more than nine measurement results, the next page is displayed with . pages back.

A single result can be selected with and .

Confirm the measurement with .



1. **Date**
   Date of the measurement.
2. **Time**
   Time of the start of the measurement.
3. **Exp. ID**
   Sequence of figures for clear identification of sample.
4. **σ**
   Measurement results in mN/m.
5. **Stdv**
   Standard deviation in mN/m.
6. **Experiment time**
   Time taken for the complete measurement
7. **Points of Stdv**
   Number of points for calculating the standard deviation.
8. **Mov. Speed**
   Speed of the sample table.
9. **Time step**
   Time increment for the individual measurements.
10. **l**
    Length of plate in mm.
11. **d**
    Plate thickness in mm.
12. Print out with .

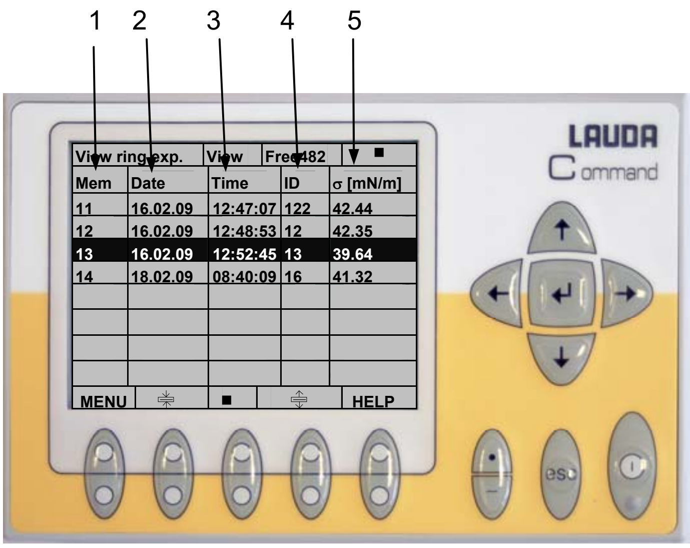
☞	The data cannot be changed retrospectively.

```
=========================
LAUDA
Tensiometer TD3
------------------------------------------
Plate measurement
16.02.09  12:38:32
Exp.ID = 189
ST = 39.91 mN/m
Stdv = 0.01 mN/m
Exp. time = 8 s
------------------------------------------
Measuring parameters
Points of Stdv = 5
Mov.  speed = 8
Time step = 1 s
------------------------------------------
Plate parameters
L = 19.90 mm
D = 0.10 mm
------------------------------------------
Printed on 12.03.09  16:05:38
=========================
```

The printout on the protocol printer contains all the data displayed in the detailed results window.

7.2.4 Ring measurement

Main menu	⇒	Experiment view	⇒	Ring measurement	⇒	

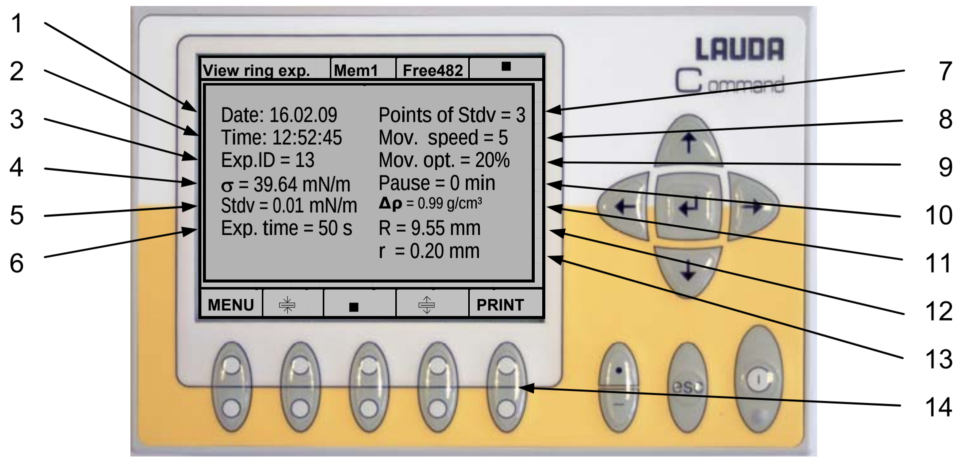


1. **Mem**
   Memory location of measurement results
2. **Date**
   Date of measurement, date of display (⇨ 4.4.6.7).
3. **Time**
   Time of the measurement.
4. **ID**
   Experiment ID (sample no.) (⇨ 5.2.2).
5. **σ [mN/m]**
   Measurement result in mN/m.

If there are more than nine measurement results, the next page is displayed with . pages back.

A single result can be selected with and .

Confirm the measurement with .



1. **Date**
Date of the measurement.

2. **Time**
Time of the start of the measurement.

3. **Exp. ID**
Sequence of figures for clear identification of sample.

4. σ
Measurement results in mN/m.

5. **Stdv**
Standard deviation in mN/m.

6. **Experiment time**
Time taken for the complete measurement

7. **Points of Stdv**
Number of points for calculating the standard deviation.

8. **Mov. Speed**
Speed of the sample table.

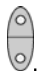
9. **Mov. opt.**
Relief of the force acting on the ring.

10. **Pause**
Pause between the individual measure-ments.

11. **Δρ**
Density of sample

12. **R**
Radius of the ring in mm.

13. **r**
Radius of the wire in mm.

14. Print out with .

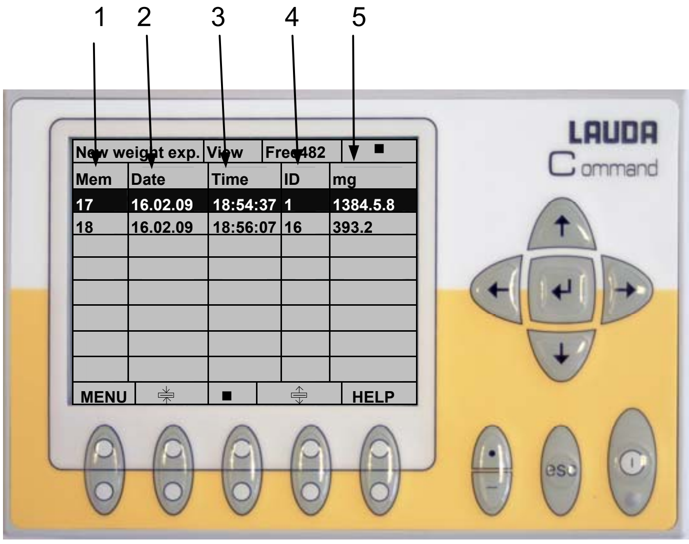
☞	The data cannot be changed retrospectively.

```
=========================
LAUDA
Tensiometer TD3
------------------------------------------
Ring measurement
16.02.10  12:52:45
Exp.ID = 13
ST = 39.64 mN/m
Stdv = 0.01 mN/m
Exp. time = 50 s
-----------------------------------------
Measuring parameters
Points of Stdv = 3
Mov.  speed = 5
Mov. opt. = 20 %
Pause = 0 min
Density = 0.99 g / cm³
-----------------------------------------
Ring parameters
R = 9.55 mm
r = 0.20 mm
-----------------------------------------
Printed on 12.03.09  16:05:38
=========================
```

The printout on the protocol printer contains all the data displayed in the detailed results window.

7.2.5 Weight measurement

Main menu	⇨	Display weight	⇨	Ring meas-urement	⇨

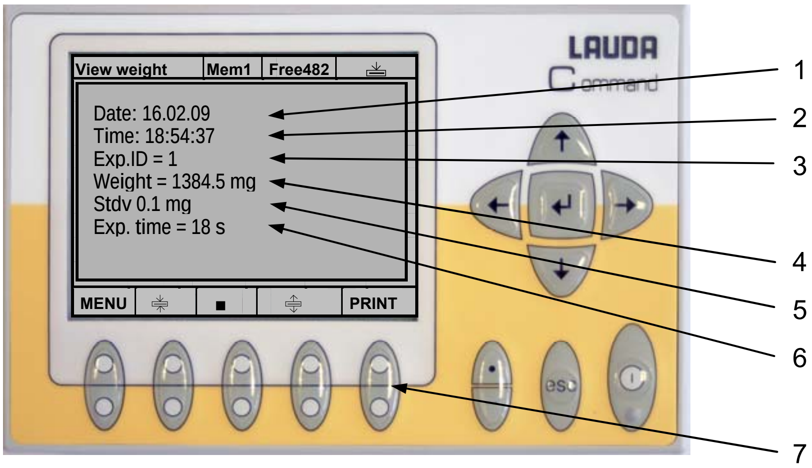


1. **Mem**
   Memory location of measurement re-sults
2. **Date**
   Date of the measurement, date of the display
3. **Time**
   Time of the measurement.
4. **ID**
   Exp. ID (sample no.) (⇨ 6.2.2).
5. **mg**
   Measurement results in milligrams.

If there are more than nine measurement results, the next page is displayed with . pages back.

A single result can be selected with and .

Confirm the measurement with .



1. **Date**
   Date of the measurement.
2. **Time**
   Time of the start of the measurement.
3. **Exp. ID**
   Sequence of figures for clear identification of sample.
4. **Weight**
   Measurement result [mg].
5. **Stdv**
   Standard deviation in mN/m.
6. **Experiment time**
   Time taken for the complete measurement [s]
7. Print out with .

☞	The data cannot be changed retrospectively.

```
=========================
LAUDA
Tensiometer TD3
-------------------------------------------
Weight measurement
16.02.09  18:54:37
Exp.ID = 1
Weight = 1384,5 mg
Stdv 0.1 mg
Exp. time = 18 s
-------------------------------------------
Printed on 12.03.09  16:05:38
=========================
```

The printout on the protocol printer contains all the data displayed in the detailed results window.

8 Appendix

8.1 Reference values for checking the TD 3

The measurement of pure liquids with known surface and interfacial tension is recommended for checking the accuracy.

☞	The reference values quoted in the literature can often only be verified with highly pure liquids and with a great deal of effort in the cleaning of sample containers and test probes and only over a short period of time. It is therefore quite possible that measurements obtained with the TD 3 in practice may deviate significantly from the reference values, particularly in the case of interfacial tension measurements.

Surface tension, [mN/m]

System	**15°C**	**20°C**	**25°C**
Water	73.5	72.8	72.00
Benzene	29.5	28.9	28.2
Ethanol	22.7	22.3	21.4
Diethyl ether		17.0	

Interfacial tension referred to water [mN/m]

System	**20°C**
Benzene	35.0
Chloroform	10.7
Diethyl ether	32.8

8.2 RS 232 interface (only COMMAND)

8.2.1 Connecting lead and interface test, RS 232

Computer					TD 3		
Signal	**9-pole Sub-D socket**		**25-pole Sub-D socket**		**9-pole Sub-D socket**		**Signal**
	①	②	①	②	①	②	
R x D	2	2	3	3	2	2	T x D
T x D	3	3	2	2	3	3	R x D
DTR	4		20		4		DSR
Signal Ground	5	5	7	7	5	5	Signal Ground
DSR	6		6		6		DTR
RTS	7		4		7		CTS
CTS	8		5		8		RTS

① with hardware handshake: When connecting a TD 3 to the PC, use a 1:1 cable and **not** a null-modem cable.

☞

- Use screened connecting leads.
- Connect the screen to the plug housing.
- Unassigned pins should not be connected.

8.3 Cleaning sample containers and test probes

8.3.1 Measuring ring and Wilhelmy plate

The best method of cleaning the platinum test probe is to heat up the parts to be wetted thoroughly in a flame.

☞	Use gases which burn without residues (Bunsen burner) or liquids (ethanol or methanol of at least analytically pure quality).
☞	Before heating up the test probes rinse them in a suitable solvent, e.g. highly pure acetone or isopropanol and dry them.
⚠	Only heat the measuring ring briefly to white heat and heat the plate only to red heat.

8.3.2 Sample containers and displacement bodies

Before being used for the first time, glass parts which are to be wetted should be rinsed with chromic or sulphuric acid and then rinsed with distilled water until neutrality is obtained. When wetting with commercially available scientific glassware cleaners containing surfactants (e.g. LABOSOL or MUCASOL), it must be ensured that **all** surfactant residues are eliminated through intensive rinsing followed by heating of the sample beakers in an oven.

Organic residues can be best eliminated by heating the beakers to 200°C.

⚠	Chromic and sulphuric acid mixture is highly aggressive and toxic to the reproductive system.

It is essential to conform to the following safety regulations when handling aggressive media:

⚠

- Follow the safety data sheet.
- Wear eye protection.
- Wear protective gloves. It is essential to avoid contact with the skin.
- Avoid breathing the vapours and work in a fume cupboard, if necessary.
- Dispose of sample materials and cleaning agents properly.

For intermediate cleaning it is often sufficient to thoroughly rinse the sample beakers with a suitable solvent, e.g. water, and then to dry them by heating them in an oven.

☞	Speeding up drying using volatile solvents, e.g. acetone, can lead to deposits of residue.

8.3.3 Cleaning the device surfaces

⚠	Withdraw the mains plug before cleaning the unit.

Cleaning can be carried out with water containing a few drops of a surfactant (hand soap) and with the aid of a damp cloth.

⚠	No water should penetrate into the device or control section.
☞	Carry out appropriate decontamination if dangerous material is spilled on or in the unit. The cleaning or decontamination method is determined by the user's specialist knowledge. In case of doubt contact the manufacturer.

8.4 Maintenance, repair and disposal instructions

⚠	– Withdraw the mains plug before all repair work. – Have repairs carried out only by specialists.

8.4.1 Maintenance

The LAUDA Tensiometer TD 3 requires no maintenance.

8.4.2 Repair information

If you want to send in a device for repair, it is essential to first contact the LAUDA Instrument Service SMG.

☞	When sending in a device, please ensure that it is carefully and properly packed. LAUDA cannot be held liable for any damage due to improper packing.

8.4.3 Disposal of the packaging

Packaging parts	Material	Disposal methods
Pallet	of laminated wood Wood for export (Douglas)	Recyclable Pallet recycling
Inner and outer packaging	Corrugated cardboard	Paper recycling
Internal foam packaging	Polyurethane (PUR) and polythene bags (PE-HD)	Plastics recycling
Cushioning damper parts (technical foam)	Polyethylene (PE) foam panels	Plastics recycling
Bubble wrap	Polyethylene (PE-LD) film	Plastics recycling
Volume filler	Air-filled polythene bags (PE-LD)	Plastics recycling
Shaped parts	Polystyrene, foamed (EPS, Styropor®)	Plastics recycling
Clear plastic folder for operating instructions	Polypropylene (PP)	Plastics recycling
Fastening tapes	Polyester tape, high strength	Plastics recycling

If recycling is not possible, the packaging parts can also be disposed of in the normal refuse.

8.5 Technical data

Types of measurement	Surface and interfacial tension; density; weight
Measurement range for ST/IT	< 300 mN/m ring; < 999 mN/m plate
⇒ Resolution	0. 01 mN/m
Temperature range	5 - 85 °C
Temperature measurement	Digital (optional)
⇒ Resolution	0.1 □
⇒ Accuracy	±0.5 °C
Density measurement	< 2000 kg/m³
⇒ Resolution	± 1 kg/m³
Weight measurement	< 5000 mg
⇒ Resolution	± 0.1 mg
Calibration	Calibrating weight
⇒ Sensitivity	3 levels
Display	Graphical display 320 x 240, 11 x 40 characters
Measuring mode selection	Menu controlled
Parameter entry	Menu controlled
Sample designation	Numerical
Measurement point interval	Selectable, 1-120 min
Measurement memory	Max. 500 results with date and time
Table movement	DC motor
⇒ Lifting speed	Selectable in 10 speeds from 0.1 - 1 mm/s
⇒ Max. lift	80 mm
Maximum detection	Automatic, sample range selectable from 10 - 100%
Ring correction	Automatic accord. to Zuidema & Waters
Magnetic stirrer	Integrated controller; magnetic stirrer attachment (optional)
Data recording	3 values / second
Stability criterion	Standard dev. normally over 3 - 9 measurements
Interfaces	RS 232
Protocolling	Printer, PC (optional)
Data trans. software	for PCs under Windows 95 and higher (optional)
Weight	Approx. 4.0 kg
Power consumption	0.01 kW
Size (meas. console)	W 250 mm x D 120 mm x H 250 mm
Mains connection	External power supply unit 90 - 264 V, batt. power supply unit (optional)

8.5.1 Order numbers and accessories

	Device type	Order no.
Standard accessories (included in price)	TD 3 (incl. COMMAND module and power supply unit)	LMT 850
	Du Noüy measuring ring (2-limb, Pt/Ir)	EZ 141
	Calibrating weight 500 mg	EZ 033-1
	Displacement body (glass, for density measurement)	UD 320
	Tweezers	EZ 034
	Set of beakers (10 pcs.) 6 cm dia.	EG 011
	Plastic case	EZ 158
Optional accessories	Du Noüy measuring ring (4-limb, Pt/Ir)	EZ 250
	Wilhelmy plate (Pt/Ir)	EZ 251
	Calibrating weight with DKD certificate 500 mg	EZ 033-2
	Set of beakers (10 pcs., for density measurement)	EG 004
	Set of beakers (10 pcs.) 6 cm dia.	EG 011
	Burning-off burner (for cleaning ring / plate)	EZ 045
Data output	Dot-matrix printer for recording the data	LMC 819
	Ink ribbon for printer, replacement	EAZ 034
	Paper roll for printer (pack of 10), replacement	EAZ 035
Software	Data transfer software for PC / TD 2/3	LDTM2017
	RS 232 connecting lead	EKS 037
Integrable PTT Peltier Thermostating Unit	PTT (Peltier thermostating unit with integrated magnetic stirrer and temperature sensor for external control, for beaker 6 cm dia.)	LMTZ 831
Standard accessories for PTT (included in price)	PTFE stirring rod	EZ 195
	Transparent plastic cover with opening	HGH 188
	Pt 100 temperature sensor for PTT	UD 711

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8.7 Help desk and ordering spare parts

When ordering replacement parts, please state the type of unit and number on the rating label on the rear panel. This eliminates the risk of unnecessary inquiries and erroneous shipment.

The serial number is composed as follows, e.g. **LMT850-09-0001**

LMT850	=	Article number
09	=	Year of manufacture 2009
0001	=	Incremental numbering.

Your contact for maintenance and expert service support:

LAUDA Instrument Service SMG

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9 Index